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ON THE LIFE OF INCANDESCENT LAMPS.

THIS most interesting subject still continues to find experimenters willing to devote time and energy to its investigation, but, as in many previous instances, we have to look to other countries than England to find them. This time it is in France, at the laboratory of the Compagnie Popp, that a series of experiments have been made, the object in view being to obtain answers to the following questions, viz.: How does the illuminating power of an incandescent lamp vary during its life? What is its mean efficiency? What is its average life?

These experiments were commenced in March last, and are still being continued; but in the meantime an account of some of the results obtained has been published in an article in our contemporary, *La Lumière Electrique*, in which the author, M. Dujon, with the aid of diagrams showing his experimental results, discusses the relation between initial candle-power and the difference of potential at the terminals of the lamp, the variations of illuminating power and efficiency at constant voltage at different periods of the life of the lamp, and the relation between the initial efficiency in watts per candle-power, the life of the lamp, and the total cost of maintenance, including lamp renewals. A large number of lamps of various types were tested, the results obtained confirming in many respects the figures relating to English and American lamps, which have been published at various times in the columns of the REVIEW, but the deductions made by M. Dujon naturally differ a good deal from those which would hold good in England, owing to the differences in the price of the lamps and of the energy supplied to them.

As regards the relation between initial candle-power and potential difference at the lamp terminals, when this latter is varied over a range of about 20 per cent. above and below the normal, M. Dujon finds that it may be expressed with considerable accuracy by the formula

$$I = K (V - a)^{\phi},$$

where I is the initial candle-power K is a coefficient depending on the resistance of the filament when cold, V is the difference of potential at the lamp terminals, and a and ϕ are constants for any one make of lamp. The values of a and ϕ are given for three makers' lamps as follows:—

Edison-Swan ...	$a = 9{\cdot}75$	$\phi = 6$
Khotinsky ...	$a = 46$	$\phi = 3{\cdot}5$
C^ie^ Française ...	$a = 9{\cdot}8$	$\phi = 5{\cdot}7$

but no values are quoted for the coefficient K. It is evident, however, that this latter may be calculated from the formula for any lamp whose candle-power at the normal voltage is known, and that then the variation of candle-power with the voltage can be determined. Thus, if we suppose that a Khotinsky lamp is taken which gives 100 candle-power at

105 volts, we should get for the value of the coefficient, $K = 0{\cdot}0000635$, and by inserting this value for K when V is made 100 and 110 respectively, we should find that the candle-power would fall to 73·5 at 100 volts, and would rise to about 133 at 110 volts.

Another result of these observations was that the curve obtained by plotting current as ordinates, and potential differences as abscissæ, might be used to give a good indication of the durability of the filament, as it was found that any abrupt change of curvature always denoted a faulty filament, whilst in lamps in which the filament was strong and did not suffer much from continual variation of potential difference, or from repeated extinction and re-lighting, this curve approached very nearly to a straight line, and that any appreciable increase in the slope of the curve, as the voltage was increased, showed that the filament, although regular and free from flaws, was relatively weaker, and would not withstand the same usage as filaments whose current curves were straight lines.

In his experiments on the variation of illuminating power and efficiency at different periods of the life of the lamp, M. Dujon appears to have found that there was not much difference between the initial efficiencies of the various types of lamps, and that in most cases the final efficiency lay between 4·5 and 5 watts per candle-power, but he shows one curve, with the comment that it is unfortunately an exceptional one, in which the watts per candle-power, commencing at 2·5, rise only to 3·6 at the end of 830 hours. It is unfortunate that in this part of his paper he does not state separately the results obtained from the different makes of lamp, as such information would have been most useful to the users; but instead of this, he contents himself with giving a general formula, which may be applied to the majority of the lamps used in Paris, viz.:

$$I_m = \frac{0{\cdot}92\ Q}{\frac{W + W_1}{2}} \times D$$

where

I_m = total candle-power hours obtained from the lamp.
Q = total watts required by the lamp at the start.
W = initial watts per candle-power.
W_1 = final watts per candle-power.
D = life of the lamp in hours.

To D he assigns the following values, depending on the initial rate in watts per candle-power, viz.:

For the best lamps, $D = 150\ W^3$.
For medium quality lamps, $D = 50\ W^{2\cdot5}$.
For inferior quality lamps, $D = 10\ W^3$.

The average life of the lamps at present sold in Paris is given as $D = 18{\cdot}7\ W^{2\cdot9}$, and the watts per candle-power at the end of this life are assigned the following values, viz.: $W_1 = 4{\cdot}9$ when $W = 3$, and $W_1 = 5{\cdot}2$ when $W = 4$. If we insert these values in the formula quoted above, we find that a 30-watt lamp starting at 10 candle-power, gives altogether 3,150 candle-power hours, or an average of seven candles for 450 hours, and that a 35-watt lamp, starting at 8·75 candle-power, gives, altogether, 7,000 candle-power hours, or the same average illuminating power for 1,000 hours. Comparing the cost of maintenance for 1,000 hours of these two lamps, we see that the latter must be charged with the cost of 5,000 watt-hours more than the former, but that the cost of lamp renewals for the 30-watt lamp will be 2·2 times that for the 35-watt lamp. In London, where the maximum price of the Board of Trade unit is 8 pence, and the lamp costs 45 pence, the balance is considerably in favour of the 35-watt lamp, as the extra charge for energy is only 40 pence, whilst the saving in lamp renewals is 54 pence; but in Paris, according to the figures given by M. Dujon, which are 1 franc per unit and 2·50 francs per lamp, it is the exact opposite, since the extra energy required by the 35-watt lamp will cost 5 francs, whilst the saving in lamp renewals will be only 3 francs. The best results are, says the author, obtained for a 10 candle-power lamp by starting at 3·1 watts per candle-power, in which case the lamp lasts for 500 hours with a mean candle-power of 72 per cent. of the initial, and costs for maintenance, including renewals, ·46 centimes, or, say, ·044 pence per candle-power per hour. It may be interesting to compare these results with what may be got from an Edison-Swan lamp, and we therefore take the following from some tables of the cost of maintenance of such lamps, which we printed in our issue of May 15th last. We then showed that a lamp starting at about 10 candle-power would burn for 900 hours with a mean illuminating power of 78·8 per cent. of the initial, and that the cost of maintenance, taking the lamp at 45 pence and the unit at 8 pence, would be at the rate of ·039 pence per candle-power per hour.

In concluding his paper, the author says that, in his opinion, we can hardly expect any appreciable improvement in the carbon filaments, and suggests that a more hopeful field lies in the trial of such materials as chalk and baryta, or oxide of zinc and other refractory metallic oxides.

NIKOLA TESLA.

IT was not to be expected that in the short evening at his disposal, and with such a host of experiments to be performed, Mr. Nikola Tesla could do more than indicate, merely, the kind of way in which the remarkable results of his untiring labours were obtained. So various were the phenomena, that even the lecturer was from time to time in doubt as to the best way of presenting the delectable feast to his guests; and so incomprehensible were the effects that he confessed, "I cannot see the forest on account of the trees."

Already the work of Mr. Tesla, with regard to currents of high frequency and high potential, had been received and appreciated in this country, as far as printed descriptions could make it plain to us. But something more was needed to impress us with the true sense of its importance. We wanted to see the phenomena themselves, and to have before us the man who had deciphered them from Nature's infinite book of mysteries.

The lecture given before the Electrical Engineers at the Royal Institution last Wednesday, was only the second which Mr. Tesla had ever given in public. At the invitation of the managers of the Royal Institution, the lecture was repeated on Thursday to its own members. There were large and distinguished audiences upon both occasions, which were enlivened, on Thursday especially, by the presence of ladies.

The first lecture which Mr. Tesla delivered on the subject of high frequencies and high potentials, was given before the American Institute of Electrical Engineers, at Columbia College, N.Y., in May, 1891. It is reported upon in our columns for July and August of that year.

With researches on high rates of discharge we naturally connect the names of such men as Crookes, Rayleigh, Spottiswoode, and De la Rue. It would appear, also, that Mr. Rankin Kennedy had already demonstrated the possibility of lighting by the means which Mr. Tesla has followed, when in 1882 Mr. Kennedy patented (No. 4,752) a method for "Intensifying fluorescent and phosphorescent electric lighting, whereby the same is rendered serviceable for illuminating purposes, and apparatus for effecting the said intensification."

Throughout his lectures, Mr. Tesla has shown a deep sense of his appreciation for those who have been before him in the field, and everywhere he has specially acknowledged his indebtedness to Mr. Crookes, whose fascinating little book he declares gave him the initiative to labour in the direction of electrical discharge. To all who would claim priority in this or any research, we recommend a careful reading of the eloquent little speech with which Mr. Tesla replied to the vote of thanks on Thursday at the Royal Institution. For this purpose we have printed it in our columns.

Mr. Tesla has many more things in view, than those he introduced to us last week. Not a third of the experiments he had prepared were actually shown, on account of the limits of time. It will be well, therefore, to reserve any criticism or discussion of the results, until Mr. Tesla has had the opportunity of describing them in detail; this, we believe, he intends to do through the press, at an early date.

It may be observed that the high frequency and high potential are obtained from an induction coil of a special form, and receiving in its primary, a special oscillatory current. Mr. Tesla sends the current from an alternating dynamo into the primary of a transformer, the secondary being connected through a magneto-static interrupter to two brass knobs, between which a series of discharges takes place. From these knobs are taken leads to the primary terminals of an induction coil, not directly, however, but through a capacity formed by Leyden jars. It is thus seen that when a spark occurs at the brass knobs, an oscillatory discharge surges through the added capacity, and the primary of the induction coil. The rate of these oscillations is about one million per second. The effect of the passage of this current, through the primary, is to produce at the secondary terminals a current, not only of high frequency, but of high potential.

When phenomena, such as those developed by Mr. Tesla, are brought before us, it is usual to seek out, on the principle of reversibility, the complimentary set of facts, advancing from where they stop, to find a return path with new beauties. In this case the result of such a line of thought leads us to the endeavours of Becquerel and Minchin to obtain currents and E.M.Fs. from electrodes, when acted upon by solar rays. In the *Philosophical Magazine* for March, 1891, Prof. Minchin writes: "It is conceivable that a photo-electric battery may yet be found which will simply act as a transformer of the energy it receives from the sun, while its own materials, being merely the implements used in the process, may be almost wholly unmodified."

The latest experiments with photo-electric cells have established the remarkable fact that when a suitable capacity is connected to them, they can be changed from an insensitive to a sensitive state by the action of a Hertz oscillator at a distance of many feet. How is this? Another analogy lies in the fact that of the liquids used in connection with the original experiments with silver plates, those which were fluorescent, such as eocine, sulphate of quinine, and fluorescine, seemed to suggest a connection between fluorescence and the electrical effect. In would be a revelation, indeed, if the light of Mr. Tesla's experiments could be found to illuminate the mysteries of those of Prof. Minchin, and *vice versâ*.

The idea of using electric lamps, without the intervention of leads, will remind some of our readers of the extraordinary telephonic experiments of Prof. Dolbear, when he delighted his audience by removing the wires connected to his receiver, and fixing the instrument some yards away from the terminals, invited those that had ears to, hear. There is, of course, a great distinction to be drawn between these results and those of Mr. Tesla. The nature of the undulations in the two cases are probably widely different.

If to the genius and imaginative mind of Mr. Tesla the number and complexity of ideas revealed by his experiments are so great that he owns himself lost in them as in a forest of thoughts, to others the darkness must be deeper still. Yet, though we cannot see even the trees, we are grateful to our distinguished visitor, for cutting us a little path, leading us a little way, and refreshing us with his great enthusiasm.

The Nature of the Ether.

WHEN we understand what ether is, we may be able to decide what electricity is. As Professor Lodge says in his preface to "Modern Views of Electricity," "that which has now to be investigated is not the nature of electricity, but the nature of the ether." . . . . Electricity has been thought to be a form of energy: it has been shown to be a form of ether. There remains the question, "What is ether? The literature of the ether is profuse, our knowledge of it diffuse. The pages of the transactions of our learned societies are, however, becoming every year richer in contributions to this knowledge, which are not merely contributions to the literature of it. And we look forward hopefully. But it is when considering what we know for certain of the nature of matter, ether, energy, &c., that we reach the humiliating realisation of how vastly little are our conceptions of them. A contribution to the literature of ether, we can scarcely say to our knowledge of it, has recently been made by Professor Nipher in a paper read before the American Association. But it is interesting to see from what point of view, and how, different scientists regard this engrossing subject. He said, that the slowing up of light in space occupied by matter shows that the ether within must be either more dense or less elastic than that existing in free space. It is certainly very difficult to understand what there can be in the molecules of matter that can increase the density of an incompressible medium. The experiments of Michelson and Morley show apparently that the ether at the surface of the earth moves with it. It is dragged along, as if it were, a viscid liquid. The field of a steel magnet is, however, a rotational phenomenon.

It is a spin which is maintained permanently without the expenditure of energy. It seems, therefore, that the resistance to shear, which shows itself in the adhesion of the ether to the moving earth, must be a rigidity due in some way to motion. Other experiments by Michelson and Morley on the motion of light in moving columns of water have been taken by some as proof that the ether in water is condensed to nine-sixteenths of its volume in air. The ether in water certainly behaves as if it were more dense, but it is another matter to say that it is so. And Professor Nipher seems to regard it as improbable. After describing what might be a more satisfactory way of making these experiments, he goes on to say that the question to be settled is, "Whether the ether, or any part of it, is at rest in space, or does it sweep through the interior of bodies, that move throughout it, as wind sweeps through the leaves and branches of a tree."

London Gas.

IN referring to Mr. Preece's lecture delivered last year before the members of the Incorporated Association of Municipal and County Engineers, entitled, "Relative Merit and Cost of Gas and Electricity for Lighting Purposes," we find the following passage: "However proud we, as gas engineers, may be of producing gas of 20 candle-power, when you come to the houses and shops of users and consumers you find this 20 candle-power is very considerably diminished. This is a very important question, and one which some six or seven years ago concerned us in the Post Office very much, and Mr. Vernon Harcourt, F.R.S., and I devoted considerable time to experiments on this question. Mr. Vernon Harcourt, who is a very painstaking, careful and accurate experimenter, found that the ordinary gas burner, *supposed to be consuming 5 feet per hour and giving 16 candle-power* in London, really gives only 10 candles, due partly to dirt in the burner, but principally to the flickering of the light of the gas caused by draughts of air in the room." It seems a pity that Mr. Harcourt did not actually ascertain what quantity of gas was passing through the burners, for, as we pointed out last week, and as this quotation shows, they were evidently not doing their duty and *perhaps* consuming only four feet of gas per hour instead of five, and we regret to observe that in Wednesday's *Daily Graphic* Mr. Preece, notwithstanding the assurance which the chemist to the London County Council gave us last week, that a good flat flame burner gives a duty of three candle-power per cubic foot of gas consumed, repeats this statement. The ordinary flat flame burner with its five cubic feet consumption is a very good rival to pit against the so-called 16 candle incandescent electric lamp, and burning under fair and normal conditions there would probably be but little to choose between them as light givers, but let us not forget to be just to each. There is too great a tendency to look upon the 16 candle-power electric lamp as always giving that light, and to compare gas under its most disadvantageous condition with it, but gas burner and electric lamp deteriorate with age, and gas engineers might pertinently enquire how many times a flat flame burner could be renewed for the price of one incandescent lamp. We fear that it would have to be confessed that the initial light from the gas burner could be kept normal by frequent renewals for a very long period before the outlay necessary for a new incandescent lamp were reached.

Communicating with the Guard.

SCARCELY a month passes but we are reminded of the utter unreliabilty of the methods of communicating with the guard of a train which are in use on our railways. Some one should collect a list of cases from the daily newspapers of the past year in which on an emergency the communication cord has been broken, or not in working order, &c. A little agitation might perhaps induce the railway companies to bestir themselves and to adopt some more reliable method of communication than that of the primitive and usually rotten cord, since there are several electric methods in the field. We are glad to see that a Glasgow firm has recently put forward an electrical alarm for trains, the object of which is to substitute a neat and efficient contrivance for the unreliable cord system. This system was successfully tested on the North British Railway at Glasgow a few weeks ago. Here is a short description:—In each guard's van and on the engine is placed an electric bell; wires run throughout the length of the train with branches into each compartment in each carriage. These branches terminate with a "push" which is placed conveniently and in full view under the parcels' rack. The "push" is protected in a manner similar to that in which the street fire alarms are protected, namely, with a metal cap glazed with a piece of thin glass; the latter is broken by any passenger wishing to raise an alarm. The manipulation of the push raises the alarm in each guard's van and on the engine. But in order to localise the disturbance or cause of alarm, each carriage is furnished with two semaphore signals, one on either side, fixed near the cornice; and they are so connected with the several pushes that when an alarm is given from any compartment, the signals on the carriage in which the alarm has been sounded attract attention. The semaphore signals are coated with luminous paint so that at night they may still be worked with their maximum efficiency. We hear, also, that the glass which protects the electric "push" is so prepared that there is no risk of cutting the hands when an alarm is raised. A dry battery furnishes the necessary energy for working this system of alarm. All we ask is, that the railway companies should seriously consider the advisability of adopting generally electricity as a means of communication on trains. If they really have an anxiety for the safety, comfort and convenience of the travelling public, as they are constantly assuring us, there can be but one course open to them.

The Electric Lighting of Larne.

ON the evening of last Thursday week a crowded meeting of the residents of Larne was held in the M'Garel Town Hall, for the purpose of considering the question of the electric lighting of the town. The Commissioners adopted electric lighting on August 1st last, and their action has recently been called in question, with a result which has triumphantly vindicated their progressive policy. The lighting has admittedly improved very much since Mr. Furniss was placed in charge of the station. Under these circumstances, it was little wonder, says the *Larne Times*, that the ratepayers of Larne, in public meeting assembled, expressed satisfaction with the improvement in the lighting of the streets, and declared "that the Commissioners deserve the best thanks of the town for their enterprise and public spirit for introducing electric light, and hereby they have our confidence and support." The public opinion of Ulster, remarks our contemporary, will endorse the opinion of the Larne ratepayers, and encourage the Commissioners to go forward, as Mr. Fullerton, their able chairman, declared, with every improvement for the good of the town and the welfare of its inhabitants. We trust that the electric lighting of Larne will now proceed smoothly and that Messrs. J. E. H. Gordon and Co. will make the installation so successful that many other towns will follow the example thus set.

THE MEASUREMENT OF ENERGY WHICH PRODUCES ELECTRICAL CHANGE.

(*Concluded from page* 123.)

THE next Section, B, in Dr. Gore's research relates to the formation of salts from acids and carbonates, and the tables give in each instance the separate amounts of the electromotive force of the acid, of the carbonate, and of the salts produced by them, also the calculated mean amounts and the actual and percentage losses of that force due to the decomposition of the carbonates by the acid.

The following conclusions are capable of being deduced from the results of the experiments in Section B :—

1. In all the cases with acids and carbonates, whatever kind of positive metal was employed, there was either a loss or gain of electromotive force due to the chemical change.

2. The losses were more frequent than the gains.

3. Whilst in Section A, when the energy of chemical union was much greater, the number of cases of loss was 81, and of gain only 1, in Section B the numbers were 57 and 13, respectively.

4. The amounts of loss or gain depended upon the same conditions as in Section A.

5. The losses were greater with formic acid and with cæsia than with all other substances, the same as in Section A, and were usually larger with very dilute solutions than with more concentrated ones, but the order of loss with salts of potassium was nearly the same with strong solutions as with weak ones, the same as in Section A.

6. They were smaller with the carbonates than with the hydrates ; whilst with aluminium as the positive metal the losses with hydrates varied from 42·7 to 13·98 per cent., with the corresponding carbonates they varied from 22·43 to 2·78 per cent.; they were smaller with the carbonates, because the energy of chemical union was less, and because a portion of the energy had already been lost during the act of union of the base with the carbonic acid ; the same circumstances explain to some extent the occurrence of gains instead of losses of electromotive force in some of the cases.

7. The magnitude of losses was largely affected by the kind of positive metal, whilst with aluminium the losses with carbonates varied from 22·43 to 2·78 per cent., with tin the variation was from a loss of 19·0 to a gain of 13·4 per cent. ; the *order* of magnitude of loss, however, was in the majority of cases, substantially the same, with different positive metals. The proportion of gains to losses was much larger with zinc than with cadmium.

The next section, C, consists of salts + salts, and includes mixtures of substances, the ingredients of which, in most of the cases at least, are not usually considered to chemically unite with each other, and in which the energy of action is very feeble, and consequently the loss of electromotive force may be expected to be very much less than in sections A and B. In this section, as in the previous ones, the ingredients of each pair are in equivalent proportions to each other, and the compounds are arranged in chemical series, so as to facilitate comparison with the atomic weights, &c., of the metallic basis.

The following remarks may be made respecting the results in section C.

1. In all the 26 instances, except one of Table XV., there is a loss of electromotive force.

2. The amounts of change of that force are all very small.

3. They are much smaller than those obtained with the same positive metal in sections A and B, where chemical action is much more energetic.

4. The results show that the method of measurement is sufficiently delicate to be employed with mixtures of neutral salts, which are not considered usually to act chemically upon each other.

Section D deals with acids + salts. The results lead to the following conclusions :—

1. A sufficient number and variety of instances of what are generally considered to be mere mechanical mixtures are given to show that such cases are attended, some by a loss, and others by a gain of energy.

2. The gains were more frequent than the losses in the proportion of 23 to 2, and were of greater magnitude. Whilst with cadmium in Table XII. of section B, when the energy of chemical union was much larger, the number of cases of loss was 14, and gain 6 ; in this section the numbers were 2 and 22 respectively, and whilst in the cadmium table of the former section the largest loss was 15·64 per cent., in this one it was only 1·6 per cent. ; in this section there was no case of large loss, because there was none of strong chemical union.

3. In this series, as in sections A and B, the order of magnitude of the results appears to agree with that of the magnitudes of the atomic weights of the metallic bases.

Section E deals with acids + acids. The amounts of change in the experiments are all very small, as in the experiments with salts + salts, and the general conclusions to be drawn from the results are largely similar to those in Section D. In this Section E, as in some others, the gains of energy are more frequent and larger with a positive metal composed of magnesium than with one of zinc.

Section	F	deals	with	alkalies	+ alkalies,
„	G	„	„	halogens	+ halogens,
„	H	„	„	„	+ acids,
„	I	„	„	„	+ salts.

In all the experiments under these sections only *gains* of energy occurred. The largest gain was 27·0 per cent. The amount of gain usually varied inversely as the atomic weight of the halogens.

Section J deals with halogens + alkalies (strong solutions). In each case the process of heating converted a gain into a loss, and the amount of change varied inversely as the atomic weights of the halogens.

Section K deals with the effect of heating aqueous solutions of the halogens. In each of the cases examined a loss of electromotive force was produced by heating and then cooling the liquid, and was greatest with bromine and least with iodine. The electromotive force of 17° C. in a solution of 35·5 grains of chlorine in 511,500 grains of water, of a voltaic couple of magnesium and platinum was 2·6124, and of aluminium and platinum 1·553 volt. The method can evidently be employed for measuring the relative amounts of change of energy caused by heating electrolytes.

In a previous research on the relation of volta electromotive force to latent heat, specific gravity &c., of electrolytes which Dr. Gore recorded in the *Philosophical Magazine* for August, 1891, p. 157, and which we noticed in the ELECTRICAL REVIEW for the same month, p. 243, the results obtained by diluting about 20 different liquids showed an increase of mean amount of electromotive force in nearly all cases ; and that if the amounts of such change were arranged in the order of their respective magnitudes, all the strong acids were at one end of the series, all the alkalies at the other end, and the neutral salts in the middle, thus forming a kind of volta-tension series. Dilution of strong solutions of acids largely increased, and of those of alkalies only feebly increased, the mean amounts of their volta electromotive force.

With regard to any relation of volta-electromotive force to specific gravity in cases of *chemical union*, various investigators have already shown that contraction of total volume of the ingredients nearly always occurs ; and that it is usually attended by evolution or loss of heat ; and the results of the present research show that these effects are very generally accompanied by *decrease* of mean amount of electromotive force. But in cases of mere *dilution*, the increase of mean specific gravity which usually takes place is nearly always attended by increase of mean electromotive force.

And now we will deal with Dr. Gore's final remarks and conclusions. The chief results of the research may be tabulated as follows :—

1. In every instance either a gain or loss of electromotive force occurred during the mixing of any two electrolytes.

2. The amount of loss or gain differed in every different case, and depended upon the nature of each of the constituents of the mixture, the kind of positive metal, and the degree of concentration and temperature of the liquid.

3. The loss or gain of mean amount of electromotive force coincided with the presence or absence of chemical change. The amounts of loss and the proportion of number of cases of loss are largest when the degree of chemical action is the greatest, and where chemical change by heating occurred. The gains are largest and most frequent in those mixtures in which no recognised chemical change took place, and in which an acid or halogen existed in a free state to act strongly upon the positive metal.

4. In cases of *chemical union* increase of mean specific gravity was usually attended by *decrease* of mean electromotive force, and in those of mere dilution it was accompanied by *increase* of mean electromotive force of the ingredients.

5. In certain cases heating the liquid permanently altered the amount of change of energy, and converted a gain into a loss, evidently because it produced chemical change. These instances may be viewed as ones of unstable mixture, the chemical equilibria of which are permanently upset by elevation of temperature, and the molecular changes of which are not reversible.

6. As action and reaction are always equal and contrary, we may conclude that the losses of energy suffered by the two mutually reacting substances are always equal in amount; this remark would apply equally to the two soluble substances during the act of mixing, and to the positive metal and the substance which acts upon it.

7. As the whole of the cases of change of mean amount of electromotive force in this research may be arranged in an unbroken series, beginning with those of strongest chemical action and ending with those of simple physical mixture and dilution, and as the relative amount of change of mean electromotive force in this series varies by insensible degrees from a large percentage of loss to a considerable one of gain, we may conclude that essentially the same fundamental kind of energy operates in all the cases; and the entire order and its energy may be compared with those of a volta-tension series of metals.

The results in general indicate the existence of an extensive system of quantitative relations between voltaic electromotive force and the atomic weights of the positive metals and of the negative and positive constituents of the compounds acting upon them; and largely, also, between the losses of electromotive force and the amount of chemical heat; the latter is already known to a considerable extent.

The following explanation is offered by Dr. Gore of the chief result, viz., that the loss or gain of mean amount of electromotive force coincided with the presence and absence of chemical action:—The electromotive force appears to depend essentially upon the degree of freedom of molecular motion. The substance which most strongly attacks the positive metal, and by neutralising some of its molecular motion excites electromotive force, is the most electro-negative constituent of the liquid. When this substance (acid or halogen) *chemically combines* with any ingredient of the mixture it usually loses heat and energy freely; by this act of union its molecules acquire less freedom of motion, and consequently can only excite a *decreased* mean amount of electromotive force with the electro-positive metal. But when the solution of this substance is only *diluted* by the second liquid, a much less amount of its molecular motion is neutralised or lost, and the molecules of the substance acquires by the dilution a larger sphere of action and an increased degree of freedom of motion, which usually more than compensates the small amount of loss of energy and of contraction of total volume of the two liquids, so that the molecules of the substance can now excite an *increased* mean amount of electromotive force.

All the results obtained appear to be consistent with a kinetic theory of chemical action, and the magnitudes of the amounts of electromotive force obtained appear to be determined by the amount of incompatible molecular motions of the mutually acting positive metal and the electro-negative constituent of the liquid. As the amounts of action and reaction are equal, the degree of energy excited, both between the two liquids on mixing and between the positive metal and the liquids before mixing and after, must be limited by the amount of incompatible molecular motion; the greater the amount of such motion in the two liquids before mixing the larger the quantity of energy lost by neutralisation of those motions during mixing, and the less the total amount of energy left in the liquid substances.

According to these views, volta electromotive force is directly proportional to the degree of freedom of the incompatible molecular motions of the electro-positive metal and of the electro-negative acid or halogen of the liquid.

We may regard every instance of chemical union, mixtures or dilution in this research as a case of balance and change of molecular motion of all the substances composing the liquid in the particular case. *Previous to mixing* the molecular movements of the liquid are mutually compatible, and therefore coexist, without neutralising one another; they are in a balanced condition, the liquid is in a state of "rest," and no heat or other form of energy is being evolved or absorbed. *During mixing*, a more or less profound change and redistribution of the movements takes place, those portions of them in the two liquids which are mutually incompatible neutralise one another, heat is either evolved or absorbed, contraction or expansion of the total volume of liquid occurs, and a change of the mean amount of those portions of molecular motion of the liquid, which are incompatible with some of the molecular motions of the positive metal, takes place.

The amount of each of these several alterations differs in every different case. In cases of *chemical union*, there nearly always occur contraction of volume, evolution of heat, and *decrease* of the mean amount of incompatible molecular motion in relation to that of the positive metal; but in those of *simple dilution*, an *increase* of the latter effect usually takes place. After mixing, a new state of balance of molecular motion occurs, and the amount of change which has happened, and the point or state of balance attained, depend upon the various conditions already mentioned. In a few cases, a temporary or unstable intermediate state of balance occurs, and the more fixed or final condition is only attained on the application of heat, &c. Immersion of the positive metal, and closing the electric current, introduce new conditions, which again disturb the balance.

Dr. Gore's theory is ingenious and elegant, and without committing ourselves to any expression of opinion as to its tenability, we do not hesitate to say that physicists have, in this new method which he has elaborated, an adjunct to research which will prove of the greatest use. In making investigations into the chemical and physical changes taking place in electrolytes, the relations existing between electromotive force and temperature, specific gravity, atomic weight, &c., we believe this method will, in very many cases, prove *facile princeps*.

SYNOPSIS OF THE HISTORY OF OZONE—1840 TO 1892.

(Continued from page 99.)

1870.—Description of a process for bleaching oils, rosins, gums, with ozone (*Journal of Applied Chemistry*).

Than produces ozone by combustion. Dr. Boeke declares that a compound of oxygen and nitrogen is thus formed, but that no ozone is produced.

Bunsen is of the same opinion as Schönbein about the nature of ozone, which, according to him, is a peroxide of hydrogen.

Faraday asserts that ozone bleaches, but that oxygen has no decolorising power.

Houzeau says that the bleaching power of ozone is 40 times greater than that of chlorine.

Von Babo constructs his ozoniser, which consists of a glass tube 1 metre long, 1 centimetre diameter.

Houzeau exhibits his ozone apparatus, which he calls *ozoniseur*, and which, according to him, produces from 60 to 120 milligrammes of ozone per litre of oxygen; electrolysis does not yield more than 3 to 5 milligrammes. Andrews, in 1856, had obtained only 4 milligrammes.

Dubrunfaut pretends that allotropic oxygen is an hypothesis, and that ozone is a mere compound of nitrogen.

1871.—Ozoniser invented by Viscilenus.

Ozoniser invented by Kolbe.

Mascart professes that there is no method by which ozone can be prepared by heat. Lœw makes experiments on production of ozone by heating the air. He applies ozone *generated by combustion of the atmospheric air* to the treatment of wines and spirits.

Giannetti and Volta publish in the *Gazzetta Chimica* their experiments on ozone, and the description of their ozoniser worked by a Holtz machine. It appears that Wright had been the first to use the Holtz machine for the same purpose.

According to the length of the spark, they obtained more or less ozone; for instance, with a 10 mm. spark and a

speed of 2 litres, 460 per hour, they had only 12·8 milligrammes per litre, while with a 14 mm. spark and 0·877 litre per hour, they had 36,900 milligrammes.

Houzeau publishes the conclusions he draws from his experiments on the relations between ozone and nitrogen, and on the difference between the disruptive and the silent discharge.

Wright makes some remarkable experiments on silent discharges by means of the high tension Holtz machine; his remarks on the *electric shadow*; on the *weak* spark, and on the influence of the tension at the poles.

Salet illuminates sulphur in glass tubes in which there are no metallic conductors.

Alvergniat announces that tubes can be charged by influence *and made to glow* with production of ozone round them.

Becquerel protests, stating that he and Frémy, many years before had produced ozone by means of tubes which did not contain any metallic wires.

Reference is made to Du Moncel and his experiments on the electric discharge between two metallic plates separated by a piece of glass; his theory. The Jean ozoniser; experiments made by Daniell; his paper on the subject.

1872.—Oxidation of alcohol by Houzeau.

Gill patents a process for bleaching and refining sugar by means of ozone.

Cross bleaches gums and rosins by means of ozonised air.

Boillot formulates his theory on the decolorising power of ozone.

Lies-Bodart shows that albumen is not attacked by ozone, and is easily bleached by it, so that it may be employed in the calico printing industry; he also shows the disinfecting properties of ozone.

Wiedeman in a note to the *Académie des Sciences* tells that in America he had started in 1869 some works where he aged and improved hundreds of barrels of whisky every day.

New experiments made by Wright; results obtained with the silent discharge; his apparatus with a ball and a disc; different effects obtained when he ozonised air or oxygen.

Reports by Dumas, Frémy, and Becquerel on the experiments made by Thénard on the electric effluvia; Thénard shows his ozoniser.

Experiments by Sir B. C. Brodie by means of a Siemens ozoniser; they confirm the results obtained by Andrews and Tait.

Chabrier ascertains by means of the Houzeau ozoniser the active properties which the silent discharge imparts to gases.

Are we bound, says Thénard, to believe, as the Germans do, that ozone is a triple atom of oxygen? His paper on this question.

Boillot employs carbon as a conducting electrode in the production of ozone.

1873.—Wills modifies the Siemens ozoniser.

Bolzano ozonises malt.

According to Boillot who ozonised air instead of oxygen, the yield of ozone with a 34 cm. spark and a 9 mm. tube at a temperature of − 13° is 21 milligrammes per 5 litres of air, but he obtained up to 52 milligrammes.

Thénard and Dumas show that the spark destroys, while the silent discharge generates ozone.

Tisley and his ozonising tube.

1874.—Reynoso is the first to use compressed oxygen in which he passes electric sparks by means of platinum electrodes.

1875.—Dall'Oppio publishes a pamphlet in which he compares the Houzeau and Thénard ozonisers.

Boillot makes some very remarkable experiments on the preservation of meat and perishable provisions, such as milk, by ozone; some ozonised meat keeps fresh during three summer months. Cross had already pointed out the use of ozone for milk.

Berthelot and his ozonising tube.

Du Moncel presents the Carvallo ozoniser for rooms and hospitals at the Académie; Thénard criticises it very severely.

Éremine writes that oxygen is much less decomposed in daylight than in darkness; his opinion is, that it will keep better in an oxalic acid solution.

Description at the *Congrès de l'Association Française pour l'Avancement des Sciences* of the ozonising tube invented by Prof. Andrews, of Belfast.

Sprague on the decomposition of water and ozone.

Results published by Ascherson on more than 100 experiments made in Africa on the ozone contained in the atmosphere.

Thénard writes that out of the two sparks of the induction coil, one only produces the effluvia.

1877.—Troost and Hautefeuille form ozone at + 1,300° and 1,400° C.

Researches by Berthelot on the causes of the influence of the variations and alternations of tension; the maximum yield of ozone he obtains is 0·08.

1879.—Renard pretends that the oxidation of alcohol is better obtained by electrolysis than by ozonisation.

Lectures by Prof. Leeds to compare the efficiency of different ozonisers. Houzeau's ozoniser gives only 0·004 milligrammes per litre of oxygen; Boillot's apparatus gives ·915 milligrammes; Siemens's tubes 23 to 28 milligrammes. The same apparatus, modified by Leeds, gives 52·5 milligrammes.

Leeds shows that ozone bleaches molasses and sugar; he demonstrates that ozone decolourises all sorts of flowers.

Berthelot asserts that oxygen and hydrogen do not combine under the action of the effluvia.

Perrot finds that the strongest electric machine gives 50 times less gas than the induction coil.

Influence of the cold on the production of ozone demonstrated by the abbé Mailfert, who employed the Thénard apparatus.

E. A.

(To be continued.)

A PORTABLE PHOTOMETER FOR MEASURING STREET LIGHTS AND ILLUMINATION.*

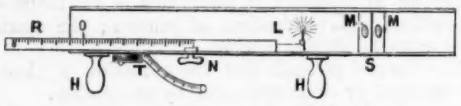
IN a paper read before the Engineers' club of Philadelphia, Carl Hering described a portable photometer that he devised for actual use in measuring the candle-power of the lights of an electric light company in a Pennsylvania town. The conditions required the construction of a portable photometer which would work equally well in all kinds of wind and weather. It had to be light and small, so as not to attract attention, in order that the electric light company should not know that the lights were being measured, and take unfair advantage of the opportunity to run up the lights. It was furthermore necessary that the results should be quite reliable, as the matter might have to go before the courts.

After several trials Mr. Hering finally constructed a satisfactory instrument by the use of an electric light supplied by a portable accumulator. The lamp used was a small four-volt incandescent lamp of about one candle-power, requiring a current of slightly less than an ampère. The accumulators consisted of two cells placed in a wooden box having a shoulder strap, enabling it to be carried by the operator at his side. The weight of it complete was about twenty pounds. The cells were sealed with lids before the acid was added, and the whole was covered with a thick layer of powdered carbonate of soda, so that if any acid did come out through the vent tubes, it would be decomposed and then evaporate. As the voltage of an accumulator will become less and less as it is being discharged it would change the candle-power of the light very materially. To get over this, the accumulators were chosen of such a capacity that the amount of current used in one set of tests was only about one-fiftieth of its capacity; the fall in potential for such a small discharge may be taken as negligible. Furthermore, as the light was turned on for only about half a minute at a time, with intervals of rest of five or ten minutes, the cells had time to recuperate. The cells were discharged slightly before the test, in order to bring them down to their normal and constant voltage. Comparisons of this light with a standard during different parts of the evening showed it to be quite reliable and constant.

The photometer itself consisted of a light wooden tube of square cross section, 4 inches to a side, about 3 feet long and open at both ends. The adjoining cut shows a view of it with one side removed to show the inside. The usual screen, S, with a grease spot, and mirrors, M, M′, was placed near the right-hand end, and a square opening left in the side of the

* *Western Electrician.*

tube opposite to it to look through. The tube was blackened inside and outside with a paint made by mixing much lamp-black with a little very dilute shellac; this paint, in drying, leaves no gloss. It was supported by two projecting handles, H, H, the right hand one being nearly under the centre of gravity, so that the whole could readily be supported by the



right hand alone. The small electric lamp, L, was secured to a block capable of being slid along inside of the tube by means of a projecting rod, R, having a scale attached as shown, which indicated the distance of the lamp, L, from the screen, S. This rod, with a lamp, could be securely clamped at any desired distance from the screen by a thumb nut, N. A 15 feet tape in a spring case, T, without pawl and ratchet, was attached on the bottom near the left handle. A small switch, not shown, for turning the electric light on and off was also secured near the left handle.

To use the photometer it must first be standardised. This is done in any convenient room which can be darkened. The instrument is laid on a table with a standard Hefner-Alteneck lamp, which is placed at a fixed and known distance opposite the right hand end of the photometer tube. The small electric light is then turned on, and moved forward or back, until the grease spot seen in the mirror, M′, on the right hand side of the screen, S, disappears altogether. The left hand side (toward the small electric light) was not considered at all. This adjustment, therefore, admits of considerable precision, as there is no difficulty in making the grease spot disappear on either one side or the other; the difficulty is in making it nearly disappear to the same extent on both sides, and it is here that the large personal error enters in ordinary photometric work in which no two operators will set it alike. After making this adjustment the electric lamp is firmly secured in that position, and the photometer is ready for use.

To use it in measuring street lamps, or any other source of light, the right hand end is pointed toward the light in either a horizontal, a vertical or an inclined direction; the small electric light is then turned on, and the whole tube moved toward or away from the light to be measured until the spot of light again disappears on the mirror, M′, to the right of the screen, S. By measuring the distance between the screen and the light to be measured, and knowing the calibrated value, the candle-power of the light is readily calculated from well-known laws. The distance from the screen to the large light is measured by means of the spring tape, T, which passes directly under the screen, and may be easily read by the operator. The small switch placed near the left-hand handle, not shown in the figure, enables the current for the small lamp to be turned on and off readily, so as not to burn it longer than just enough for the test.

In Mr. Hering's measurements the lights to be measured were from 10 to 25 candle-power, and it was thought that from 4 to 6 feet of tape was a convenient distance, being an average of about $1\frac{1}{2}$ inches per candle. This would require, as a unit of illumination of the screen, a little less than one-foot candle. For convenience in making calculations the standard was placed at $14\frac{1}{8}$ inches ($= \sqrt{200}$) from the screen in the calibration. This gave such a unit that the square of the distances in tens of inches is double the candle-power of the light to be measured, a calculation which is readily made mentally, approximately at least. A difference of one candle-power in the unknown light would therefore require a movement of the photometer of about $1\frac{1}{2}$ inches; a fraction of a candle may, therefore, readily be detected; hence the photometer was quite sensitive for this class of work. The end of the tape was held up to the centre of the lamp by an assistant with the aid of a pole. The spring case of the tape kept it stretched so that the tape was virtually a fixed rule or scale over which the whole photometer was moved. The right-hand end of the tube must be long enough to shield the screen from the light of other light or of the moon.

This form of photometer has the further advantage that it can be used to measure "illumination" as distinguished from the candle-power of a light.

To use this photometer for such measurements, the right-hand end of the tube is made in such a way that it can be taken off, so that the grease spot screen forms the end of the tube. The photometer is calibrated, as before, but instead of securing the rod containing the little lamp, its position should be read on the scale shown in the figure, the zero of this scale being such that the reading gives the distance of the small light from the screen. Being thus calibrated, it is ready for use. To use it, as for instance, to measure the illumination on a desk produced by daylight, the photometer is placed vertically, so that the screen is on a level with the desk, and the electric light is moved in its position until the grease spot disappears. From the reading of this position, and that of the calibration, the illumination in foot candles is readily calculated. From this the number and position of electric or gas lights necessary to reproduce such an illumination may then readily be calculated.

ELECTRICITY AND AERONAUTICS.

A SUCCINCT history was given a short time ago by Mons. G. Dary in *l'Electricien* of the vain efforts that have been made at different times to propel and steer balloons through the air; and a careful study of these make it clear that one of the most powerful factors which have determined the non-success of these experiments has been that balloonists have increased the dimensions of their globes in order to increase at once the proportion of ascensional power and of motor and propulsion energy to resistance, whereas more success would probably in this have been attained if the function of the balloon as a sustainer had been reduced and the propulsory organs had been brought into greater prominence.

The idea of propelling machines heavier than air through the air originated according to classical traditions with Architas, yet it is only to-day that attempts are being made to exploit this idea. Scientists are taking up the study of aerial navigation now: hitherto it has been left to ingenious but usually ignorant faddists; the result is that the solution of the problem is now regarded as depending solely on the discovery of a light and powerful motor.

Our contemporary, *Le Monde de la Science et de l'Industrie*, recently contained a valuable paper upon the present position of aerial navigation from the pen of Mons. G. Trouvé who is well known as an ardent believer in the flying machine, and whose researches have done much towards bringing it within the range of the possible. His paper is chiefly interesting to us inasmuch as it discusses the value of the assistance which electrical machinery can, in its present state, afford to the aeronaut.

Electricity, although better in many respects than steam, gas, or such accumulations of energy as steel springs, compressed air, &c., is open to plenty of criticism, at least in respect to the manner in which it has hitherto been applied. There appears, however, to have been one series of experiments at least in which the application of electricity has been attended with results which were at least highly encouraging.

In 1887, at the scientific congress held at Toulouse, and again in the following year at the Easter session of the Société de Physique, experiments were conducted by Mons. Trouvé, which were in effect as follows:—

An electric motor constructed entirely of aluminium with the exception of the poles, which were of soft iron, was employed. Its weight was ninety grammes, and its power measured by a dynamometer, maintained at two kilogrammetres, which corresponded exactly with one horse-power per 3·375 kilogrammes. The motor was armed with a light and geometrically accurate propeller, made according to the method explained to the Academy of Science at Paris, on July 12th, 1886. The motor having been placed in one of the scales of a balance and put in connection with a source of electricity maintained constant at forty watts, was found capable of raising its whole weight.

In order to render more visible the extent of the result attained, a light balance was arranged with long arms, to one of which the motor was attached. The electric communications were carried through the foot, knife-edges, and arms of the balance, so that the freedom of its motion was mim-

paired. The balance was capable of movement horizontally and vertically. With this arrangement the measure of success obtained appeared even more pronounced. The power developed by the motor was found by the most careful measurement to be so related to the weight of the motor as to be capable of raising it vertically twenty-two metres in a second.

A simple theoretical calculation deduced from the above experimental fact assigns 3·375 kilogrammes to the motor that will develop 75 kilogrammetres. But so minute a motor returns only about twenty per cent. of the energy which is put into it, while a motor of from 50 to 100 horse-power will give a return more nearly approaching to the cent. per cent.

It is possible, therefore, and seems reasonable that a large electric motor, the power of which should increase faster than the weight, would employ the surplus in raising the generator, the propellor and the aeronaut.

But it is rather disappointing to find that having attained such a measure of success as this with electricity, Mons. Trouvé now "flies off at a tangent" and is now busying himself with the fad of compressed gases, thus illustrating the erratic ways of men who might be great if they would only allow themselves a chance. He gives a long and enthusiastic description of his experiments with mixed oxygen and hydrogen; these gases appear to be used in a sort of cartridge placed in a small model resembling in shape a bird, and on being detonated the force of the explosion causes the wings to beat the air and the model to "fly."

If Mons. Trouvé will forgive us for saying so, we fear that it is he that is "*beating the air*." If he would turn his efforts towards developing the idea in the apparatus we have described, and which he calls the "electric helicopter," he would be doing work that is worth spending time and trouble over. The promise of success is most inviting, and why he should leave his scientific researches in order to stuff model birds with gas and make them "go off," we cannot understand.

What is wanted is, that practical men who are themselves sound scientists should investigate this question of aerial navigation and that their researches should be published, so that incompetent faddists may be deterred from wasting capital over impossible machines, and so that the inventors who come after may know in what direction *not* to attempt discovery.

AN ELECTRICAL CENTRAL STATION AT FIUME.

[FROM OUR OWN CORRESPONDENT.]

THE International Electric Company of Vienna has erected at Fiume an electrical central station for lighting and transmission of power on the system of alternating currents with transformers. This station, which was set in action in August, 1891, is of great interest on account of its simultaneous application for the supply of light and power on a large scale. The area which is supplied with current from the central installation is the territory of the newly constituted free port, with its extensive magazines, the adjacent moles of the commercial port, the lighthouse at the end of the breakwater, the buildings of the railway stations, the trans-shipment yard and stores of the Royal Hungarian State line, and lastly, the offices of the Hungarian finance authorities.

Within the territory of the free port is the main elevator of the Hungarian Discount Bank, the mechanical arrangements of which are entirely actuated by alternating current motors, whilst its rooms are lighted by glow lights.

It must be especially mentioned that in the territory of the port all the leads and arc lamps are fitted at suitable points, with connections from which leads can be made to branches for lighting the holds of the ships lying in the port for the purpose of loading and unloading by night.

Description of the Central Station.

At the north-western end of the city in the suburb Mlaka the electric central station is erected upon a plot of land acquired from the Hungarian State Railway.

In the engine-house there are erected at present, three one-cylinder high-pressure engines, each of 125 H.P. and working at 360 revolutions per minute, built by the Joint Stock Machinery Works at Brünn. Their crank-shafts are directly connected with the alternating current machines and their accessory exciters. Space for the erection of a fourth engine is already provided, and moreover the foundations for the offices and dwelling-houses, situate in the line of prolongation of the engine-house, are constructed in such a manner that they can, if required, be converted into an engine-house, and will supply space for setting up three more engines. The boiler-house is joined up directly to the engine-house. It contains three tubular boilers on the Babcock and Willcox system, each of 150·56 square metres heating surface for a working pressure of 150 lbs.

The chimney is built into the boiler-house, and the spare room is reserved for the erection of two more boilers, but at present it serves as the workshop for repairs. In the narrow space between the chimney and the wall dividing the engine house and the boiler house a reserve rheostat has been placed. The steam given off from the engines passes a large preliminary heater and warms the feed water to about 90°. A vertical pump worked by steam feeds the boilers. It draws the feed water directly from a stream flowing at the distance of about 80 metres from the central station, and forces it through the preliminary heaters into the boilers. A tank placed beneath the floor of the boiler house of 5 × 3 metres surface, and 1·5 metres in depth, forms a store for feed water from which the injectors draw their water as a reserve feed arrangement.

The alternating current machines (type A 6) run at 360 revolutions per minute, and about 5,000 alternations; they each give 40 ampères and 2,000 volts. They have been built by Ganz & Co., of Budapest, on the Zipernowsky system. The exciter machines, type Δ_3 of the same firm, are connected to the alternating current machines by means of flexible couplings.

The alternating current machines consist, essentially, of a magnetic wheel of 14 magnetic limbs keyed upon a horizontal shaft, which serves, at the same time, as a flywheel, and, secondly, of a fixed circle of bobbins surrounding the magnetic wheel.

The degree of magnetisation of the machine can be modified in proportion to the load. An automatic rheostat, on Blathy's system, is introduced for the automatic regulation of the tension.

From the central station aerial bare copper three-wire conductors pass to the places where the current is consumed; a primary lead for lighting the port and the station yard; a primary lead for power in the elevator, and a secondary lead for the circuit of arc lamps in the trans-shipment yard. This yard is lighted with eight arc lamps of 12 ampères; the port is lighted by 26 arc lamps of 12 ampères, arranged on three circuits, two of which comprise each nine arc lamps, and one supplies eight arc lamps. To feed these circuits with a current of 300-volts tension for the railway station, the transformers, are introduced by threes in series, whereby each transformer can also feed glow lamps at 100 volts.

For lighting the station buildings there are used four arc lamps at 8 ampères, two do. at 12 ampères, 40 glow lamps at 10 normal candles and 74 glow lamps at 16 normal candles; further, the warehouses of the Hungarian State line, and the warehouses and offices of the territory of the free port, have together 140 glow lamps at 16 normal candles and 200 glow lamps at 10 normal candles; finally, the lighthouse at the end of the breakwater, with two glow lamps at 100 normal candles; special transformers are attached to the primary leads. The conduction of the transformed current to the lighthouse is effected by a submarine concentric cable of 250 metres in length. For lighting the ships anchored in the harbour, the elevator (above mentioned), and an extensive establishment for cleansing grain, provision is also made. Five of the elevating appliances are propelled each by a 10 H.P. alternating current motor; one of them is driven by a 20 H.P. motor, which at the same time supplies power for the transport of grain.

For the cleansing process two 10 H.P. and two 20 H.P. alternating motors have been erected. In all, the elevator at Fiume has seven 10 H.P. and three 20 H.P. motors; the former are connected directly to the secondary net, whilst the

latter are attached to the primary net; both types of motors make 830 turns per minute, and act directly upon the disc of the elevator works, whether full or empty. The management of the motors are simple and their working is certain.

In consequence of the great extension of the installation, which covers a surface of 68 metres in length by 24 in breadth, the choice of the electric current as motive power has proved itself, from many points of view, extremely advantageous. This method of the transfer of power allows of a high economic effect of the motors, and an accompanying decentralisation of the distribution of power. It renders it possible to dispense with a complicated transmission, the construction and management of which must be costly, independently of the loss of power to be expected, if we consider that the building of 40 metres in height is entirely constructed of wood, and in consequence of the extreme differences of atmospheric moisture prevailing at Fiume, is exposed to continual displacements. The electric transmission of power allows the motor to be placed close to the place where the power is to be consumed.

MR. TESLA'S LECTURE.

AT the close of the lecture by Mr. Tesla, on Thursday, last week, the vote of thanks of the members of the Royal Institution was proposed by Lord Rayleigh, and put to the meeting by Sir Frederick Bramwell, as follows :—

Lord RAYLEIGH : Sir Frederick Bramwell, ladies and gentlemen,—Although it is not our custom here to follow the lecture with remarks from anyone else, I think you will agree with me that this is no ordinary occasion. At the request of the managers of the Institution, and for the delectation of its members, Mr. Tesla consented to repeat the labours of last night, labours which, though small to him, would have completely exhausted anyone else.

I wish our great electrician, whose name appeared before us in letters of fire, in one of Mr. Tesla's experiments, were here to propose this motion. There is only one respect in which I have any qualification to speak, and that is that I have made attempts myself to experiment with currents of a high degree of frequency. I was tolerably satisfied when I had a discharge rate of 2,000 per second, but we have had to-night ten or twenty thousand per second. My apparatus was on a very small scale indeed. Mr. Tesla has taken us into some of the dark—metaphorically dark—places in nature. These fields have been but little trodden, Mr. Crookes and Mr. Tesla alone have had the *entrée*. In what has been put before us to-night, there has been matter which will afford food for intellectual contemplation for a long time to come. I think, at the same time, it will be obvious to you that Mr. Tesla has not worked blindly or at random, but has been guided by the proper use of a scientific imagination. Without the use of such a guide we can scarcely hope to do anything of real service. I do not think there is anything I need add; it does not require any great capacity to see that Mr. Tesla has the genius of a discoverer, and we may look forward to a long career of discovery for him. His labours will be followed with admiration by all men of science of England, and especially by those in this Institution to whom he has done the favour of lecturing to-night. I thank Mr. Tesla for his lecture.

Sir FREDERICK BRAMWELL : Ladies and gentlemen,—I believe it is usual to second the vote of thanks. I, for one, should be very glad for Lord Rayleigh to put the motion to you. It is the duty of myself, however, to second this vote, which I do most heartily. Our treasurer is not here to-night; he foresees as the result of the lecture, that the whole of our apparatus, in this line of study, is antiquated, and we shall have to begin afresh. This has evidently been too much for our treasurer, and he has consequently stayed away. In my own province of mechanical engineering, there was a time when we were content to have boilers which would be ridiculed now; and turning from mechanical engineering to electrical science, we have seen to-night the same development from the slow-going, old-fashioned style of phenomena, as that which I have referred to in the case of the steam boiler. I can only regret that Mr. Tesla has kept within the limits of time, and has had to refrain from giving us that which we so much liked. I wish he could give us another evening, and show us more of the experiments. I put the vote to the meeting.

Mr. TESLA : It would be difficult for me to find words to express the thoughts I feel; I have been so kindly received and generously treated. Whatever I have shown you here is not my own, it is the outcome of the work of English scientific men, whose names we delight to hear, and whom everyone loves and admires. To-night my aspirations are fulfilled in having my labours appreciated by some of the foremost men in the world, and I cannot tell you how highly I esteem your thanks, and how much it will encourage me to further work. There is one thing I desire to tell you—I am not a speaker, nor did I prepare to speak at all, and these two considerations should disqualify me at once—but this I want to say : We have worked before with the problems that are at hand until they have been perfected. The water wheel, the gas engine, the steam engine, thanks to the great spirits which your country has produced, are brought to a high state of efficiency. In these departures we have come, so to speak, to the limit. We have now a possibility opened to us of accomplishing things we never dreamed of before, and in this lies the whole aspiration of scientific investigators. These contrivances are but in an imperfect state; they have consumed many years of my incessant thought, some other experimenter will start where I have stopped, and so the world goes on; but the same advantage which another will have from my work, I have already had myself, from those who have gone before. The foremost scientific men of this country agree that there is a way of producing the electric light by fluorescence as the result of oscillations of a certain frequency. I will not dare to speak of what they have achieved in this direction, for if I do, my discourse would be the praise of their work; it is, therefore, out of place. You will believe that these words are sincere, even if they are not put forth in the expressions of a good orator. We have a start. We can set up in a room the oscillations, and the only difficulty with which we are confronted is the perfecting of the apparatus. Thus we can have a light which will not need any leading wires, which will be a good luminant, and will never be destroyed—it will last for any length of time. This will be a great advancement over present methods. These difficulties are nothing compared to the problems English scientific men have opened up before. For instance, in the production of power. We are able to produce power at any point in the universe, and when this great work is finished, what an effect it will have upon the whole human race! I wish to say that the results I have shown you to-night are the outcome of the work of others, and I do not want to impress you as though I was displaying any discovery of my own. If anyone can reap the benefit of it, my desire is fulfilled. I am only paying a duty which any lover of science must pay to those who have been before in the field. Others have arrived at results. We are younger, and we go on from them, climbing the stairs; or, rather, we younger ones are taking the "lift"—we are using the "elevator." The older ones were content with the stairs! I thank you most heartily, and express the hope that I may be able to bring before you some better work than I have shown you to-night.

BRUSH'S HOT STRIP AMMETER.*

IN this ammeter the strength of the current is indicated by a pointer moved over a scale by the expansion and contraction of a metal strip which carries and is heated by the current to be measured.

The device as here shown, which was designed by Chas. F. Brush of Cleveland, is very simple in construction. Figs. 1 and 2 show the external and internal appearance of the meter, while the details will be understood by reference to figs. 3, 4, and 5.

The working parts of the meter are enclosed in a case of

* *Western Electrician.*

cast iron. From figs. 2, 3, and 4, it will be seen that a thin flexible ribbon loop of German silver is attached to a rock shaft at the top, while at the lower end of the casing the ends of the ribbon are fastened to the screw rods, which extend through insulating sleeves. Washers surround the

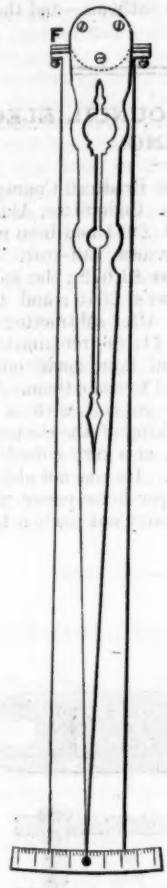


FIG. 1.

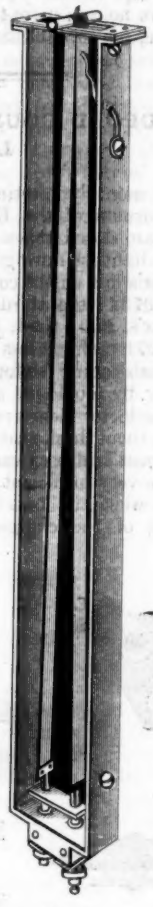


FIG. 2.

screw rods and are seated upon asbestos and mica, as shown, in order that the washers and screw rods shall be insulated from the casing and from each other. As will be seen, there are adjusting nuts to regulate the tension of the ribbons. One of the screw rods is fitted like a binding-post to receive one end of the circuit in which the instrument is to be included. At the upper end of the casing there is a spring plate, figs. 3 and 5, which carries the rock shaft sustaining

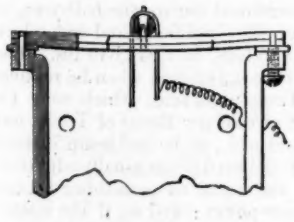


FIG. 3.

FIG. 4.

the ribbon loop. The rock shaft has a roller bearing on the spring plate, and it is provided with holes into which the pins, set in the spring plate, extend, as indicated in the large sectional view, fig. 5. A pin fastened to the rock shaft passes through a hole in the ribbon. This construction prevents the ribbon from slipping upon the rock shaft. The long pointer, fig. 1, is fastened to one end of the rock shaft.

It should be explained that Mr. Brush found by practical tests that an ordinary knife edge bearing would soon deteriorate, and for this reason he adopted the roller construction as shown in fig. 5.

The meter is operated as follows. The adjusting nuts are first turned down so as to impart considerable strain upon the two parts of the ribbon and the spring, and when properly adjusted, the hand will point to zero on the indicating scale. When current is passed through the instrument, it flows, as shown, through a part of the ribbon. The current, therefore, heats this part of the ribbon, owing to its resistance to the passage of the current, and the degree of heat to which the part is subjected varies with the strength of the current flowing through it. The heating effect of the current

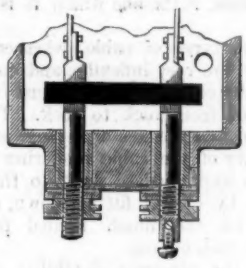


FIG. 5.

operates to expand this portion, and as it slackens it relieves the spring plate of a portion of its restraining force, and thus allows it to retract. But owing to the fact that one part of the ribbon is not expanded, this part still exerts its normal restraining force on the spring, the result of which is that the latter will partially rotate the rock shaft and cause the pointer to move over the indicating plate, the extent of movement being dependent upon the strength of the current flowing through the other part. It should be mentioned that the operation of the instrument is not due to the amount of heat to which part of the ribbon is subjected, but to the difference in heat to which the two parts of the ribbon are subjected.

COMMUNICATION WITH ROCK LIGHT-HOUSES.

A CORRESPONDENT sends us the following description of a chain armour designed for the protection of cables employed in connecting up rock lighthouses with the mainland. The idea seems to us not without its merits, and as everything original tending to overcome difficulties should be encouraged, we publish his remarks together with drawings of the chain.

"It is pretty certain that if telegraphic communication is to be successfully established with our rock lighthouses—such as the Fastnet, for instance—it is to be done by a liberal expenditure in the first cost of the cables employed for the purpose, and by exercising great care in their laying. Startling as the opinion may appear, it is nevertheless very questionable whether the ordinary types of submarine cables are altogether suitable for irregular rocky bottoms with shallow water and strong tidal currents. That some cables do last under these conditions is perfectly true, but the conditions to which they are exposed are not so severe as those to which a cable laid to the Fastnet would be necessarily subjected. In this case there is practically no choice of landing places and practically no side of the rock which is not exposed at some time or other to very heavy seas. It is therefore reasonable to conclude that a cable which would last under these circumstances would serve for any other of the numerous rock lighthouses and signal stations around our coasts.

"Let us examine what are, to the best of our knowledge, the causes of rupture in a cable exposed to such unfavourable conditions and endeavour to provide against them. These causes are principally—

"1. Damage by ships' anchors.

"2. Abrasion caused by boulders of loose stone being washed over the cable either by strong currents, or in shallow water by actual seas.

"3. Abrasion caused by the cable moving on the bottom with currents or seas.

"The first cause is one which it is impossible to effectually provide against. A heavy cable by no means affords security. In the case of a lighthouse cable there is less risk than usual, since the lighthouse itself affords absolute protection to a considerable portion of the cable.

"The second cause is one to which the ordinary type of cable is constantly exposed and which it is fairly successful in resisting. The rocks on which lighthouses are built are generally quite bare and free from moving stone. Rupture from this cause is not therefore to be expected.

"The third cause is the one which it is most difficult to provide against.

"The ordinary types of cable, whether heavy or light, long or short lay, are very inflexible and consequently, under the most favourable conditions, there must frequently be short lengths suspended from rock to rock. This suspension is sometimes caused by tightness of laying, but more generally by the inflexibility of the cable rendering it absolutely impossible for it to accommodate itself to the irregularities of the bottom, and by closely fitting down, obtain from these very irregularities the much needed protection against currents and the rush of seas.

"To obtain the necessary flexibility, and consequently protection to the cable, is therefore of the very greatest importance, and having obtained it the next point is the specific gravity of the cable or, more accurately, the relation between the surface exposed and the weight in water.

"Iron is the usual armour for cables and has a high specific gravity (say 7·8), but in the form of cable usually employed much of this valuable quality is lost by the use of hemp yarns, which its construction renders absolutely necessary. The specific gravity of a heavy cable is somewhere between 3 and 4.

"The proportion of iron in a cable should therefore be such as to give the greatest specific gravity possible.

"It is with these objects that the chain armour as shown in the accompanying drawings has been designed.

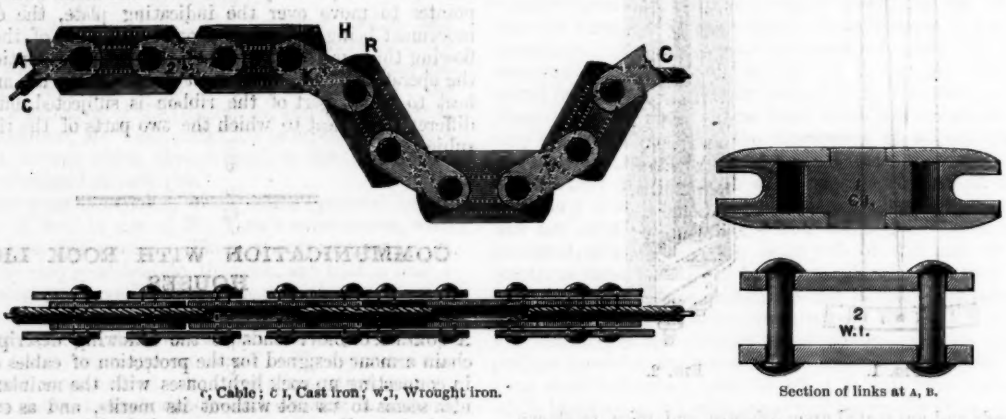
"1. The chain is perfectly flexible. The weight of the cast iron links being considerable and the cable threaded through them of small size and constructed to give, in itself, all possible flexibility.

"2. Whatever may be the position of the chain when ultimately resting on the bottom, the cable is always protected and firmly held in the castings, and all wear and tear between itself and them prevented.

"For instance, at the bend in the chain, as shown at H, fig. 1, the slack from the end of the link at K, is taken up by the next link at R.

"3. With care in laying the cable, it should be possible so to zigzag it about and fit it into the irregularities of the bottom (perhaps with the aid of a diver), that no great length of it would be exposed to the action of any sea, and the whole chain being actually resting on the bottom, any serious movement would be avoided. This movement would in any case be far less likely to occur on account of the specific gravity of the chain. It is well known, that granite boulders are frequently tossed about by the sea, but the specific gravity of granite is only about 2½, whereas, that of the chain, would be about 7.

"4. The use of the chain armour would naturally be only necessary at exposed positions and on rocks. On the first piece of favourable ground being met, with fairly deep water, an ordinary type of cable would be spliced to the small type, with an overlapping splice, and the ends of its sheathing wires would be secured to the last casting of the chain which would be of special construction. The length of the chain armour required at any end of a cable would, therefore, be small—in no case more than 200 fathoms—and the expense, therefore, not prohibitive."



C, Cable; C 1, Cast iron; W.I, Wrought iron.

Section of links at A, B.

BRADFORD COUNTY COUNCIL ELECTRIC LIGHTING.

AT the monthly meeting of the Bradford County Council, the chairman of the Electricity Committee, Alderman F. Priestman, stated that a profit of £971 had been realised on electric lighting during the previous half-year. The first half-year's loss on the concern was £1,079; the second half-year's, £732; the third half-year's, £315; and the fourth half-year's, £30; total, £2,157. After subtracting from that total £971 profit, a loss of only £1,186 remained. A great many misleading statements had been made outside that building by people not authorised to make them. They had been made to members of the council with a view of making them think that the working of the electric lighting department had been carried on at a very considerable cost and in a very inefficient manner. He was not able to say at present what the cost in coal per horse-power was in the working of the engines. To carry out such a test it was necessary to have a separate engine and boiler, to weigh the water and weigh the coal. Somebody had stated to him that the cost was something like 16 lbs. per horse-power per hour. He hoped very soon to be in a position to have a test made, and he would ask some independent gentleman to come down to verify the facts and figures. He would bring before the council an exact statement with regard to the efficiency, not only of the engines, but of the boilers themselves. The coal which had been consumed during the half-year, without reckoning the stocks at the beginning and end, which were about the same, was 865 tons, or 1,942,640 lbs. The total cost of that coal had been £342, and when he reckoned the number of Board of Trade units sold, which were 154,431, he found that the cost of coal per Board of Trade unit had been 12·58d., not 30 and 34d., as he had heard it stated outside that building.* He believed it was usually admitted that a Board of Trade unit was equal to something between one and a-half and two horse-power; and so, if the matter were reckoned out, it would very soon be found what had been the number of pounds per horse-power that had been consumed. The average price of coal—and this was a very important thing to take into account—had only been 7s. 7d. delivered at the works. You had to consider a great number of things in reckoning up how many pounds per horse-power were burned. In the first place, there was the banking up of the boilers all the night and all the day when the light was not on. There was also the lighting of the station. Nothing whatever was reckoned for that, and there was always in the evenings a very large amount of coal consumed for the purpose. Then there was the resistance in the mains,

* See our "Notes" columns.—EDS. ELEC. REV.

which was an entirely unknown quantity. But he was informed that 20 per cent. was a low estimate of the amount required to get the current through the full system before it acted, and this had to be accounted for in estimating the consumption of the lamps. Another very important direction in which coals were consumed very rapidly was in the trials of the engines. Every one of the engines before it was passed and paid for had undergone a full 12 hours' running without standing for a minute, and whenever these trials had not been satisfactory they had been made over and over again, and the last engine, he might say, had not been passed and had not yet been paid for by the Corporation; so that he could not estimate, nor could anybody else, the amount of coal used in these trials, which were of a very severe character. He hoped these figures would be closely gone into by the electric lighting journals, and that there might be a discussion upon them, so that it might be seen whether any other station was better than their own, and if so, why—in order that if they extended their electric lighting plant they might make any change in the system which might appear desirable. But he ventured to say that Bradford would come out, if not the best, at least amongst the best, economically considered, of all the stations in existence, and his own opinion was that if they had to start again, and if they were well advised, they would start exactly on the system on which they started no fewer than three or four years ago, and which system they had carried on so far successfully, and successfully not only from a scientific point of view, but, as he had been glad to be able to show them, from a financial point of view as well.

THE GÜLCHER THERMOPILE.

IN the first number of the current year of the ELECTRICAL REVIEW (page 8), we published some criticisms on an article written by M. Julius Maier in our contemporary, *Electricity*. In this article, we, on the basis of the figures given by M. Julius Maier, established the impossibility for the biggest Gülcher thermopile to give more than 6·1 watts, under the conditions of maximum available power, and to light, as M. Maier affirmed in his article, one six-candle lamp for *twelve* hours daily.

That was true and remains true, notwithstanding all the protestations made by M. Maier in the last issue of *Electricity*, for he offers no argument at all combatting our criticism. The article of M. Julius Maier reads as follows:—

In the article on the Gülcher thermopile, published in *Electricity* No. 59, p. 474, some statements occur on the burning of 6-candle lamps, which require some explanation. These statements were taken from a pamphlet, printed during the time of the Frankfort Exhibition, held last year, and referred to the pile exhibited there, which, consuming about 250 litres of gas, actually generated an available maximum energy of 10 watts. It must further be added that the quoted 6-candle lamps (made by the Allgemeine Elektrizitäts Gesellschaft, of Berlin) do not take more than 15 watts—*i.e.*, 2·5 watts per candle—and this "strain" has proved not to be too great for the purpose of short and temporary lighting, such lamps having been used for several years, without one having been replaced yet. Finally it must be mentioned that the *automatic switch* (specially designed by Mr. Gülcher for the said purpose, and being actuated merely by the draught of the burnt gases rising from the pile) in connection with reliable accumulators, such as those of the Correns type, reduces the loss of energy to only 10 *per cent.* Thus our statements will be found to be correct.

In the article referred to above, mention has been made that the small type Gülcher thermopile has recently been reconstructed and considerably improved as to its durability. Instead of the former type, exhibited at Frankfort, and mentioned above, the makers now recommend the No. 3 pile of the new type for charging small accumulators. One of these piles (consuming 170 litres of gas per hour), in connection with the "automatic switch," and eight accumulators, will therefore (according to the figures given) supply an energy sufficient for burning daily:

One	6-candle lamp	for 9	hours
Two	„ lamps	„ 4½	„
Three	„ „	„ 3	„
Four	„ „	„ 2¼	„
Nine	„ „	„ 1	hour, &c.

It is sincerely to be hoped that Mr. Gülcher's ardent and persevering endeavours of finding a practical means for the direct conversion of heat into electricity will be crowned by final success before long. From information received by the makers of his thermopile, I conclude that Mr. Gülcher expects that the efficiency of the large type piles (based on entirely new principles, but still being in an experimental stage) will be about four times that of the now finished small type, and that the experiments thereon will be finished in the course of this year.

It remains for me to add that my attention was called to this subject by an article in the ELECTRICAL REVIEW of January 1st, where doubt is expressed as to the truth of my statements concerning the Gülcher thermopile, and also as to my knowledge about the formula giving the available maximum power of a thermopile. Without entering upon this latter insinuation, and quite willing to concede the palm as regards personal abuse to the ELECTRICAL REVIEW, I have simply to remark that the figures published in *Electricity* were communicated to me by the makers of the Gülcher thermopile, the firm of Julius Pintsch, of Berlin, whose reputation is well known in this country as well as abroad, and is a guarantee in itself for the correctness of their statements. Besides that, I have myself *seen* the Gülcher thermopile *working* at the Frankfort Exhibition last year, amongst others, in connection with eight accumulators and a 6-candle lamp, which enables me not only to confirm the information received to be true, but also to state that the successful application of the Gülcher thermopile for short and temporary lighting in small installations is no longer a matter of possibility but of fact. I doubt very much whether the person responsible for the remarks in the ELECTRICAL REVIEW has ever seen or tested a Gülcher thermopile, and if he has not, he certainly has no right to throw doubt on the statement of others who speak from *experience*.

A French proverb says that *Tout mauvais cas est niable*, but the negation of the particular *mauvais cas* in which M. Maier has put himself cannot be accepted by us. In his former article, he was questioned on the thermopile described, and not at all upon the new type referred to to-day, consuming 250 litres of gas and giving 10 watts. The type alluded to by M. Maier, having an electromotive force of 4 volts and an internal resistance of ·65 ohm, cannot give more than 6·1 watts. We supposed in our calculations the 6-candle lamp consumed 20 watts. M. Maier knows of a 6-candle lamp consuming only 15 watts. We accept with some reserve this very low figure; we accept also with the same reserve accumulators having an efficiency in energy of 90 per cent.; but we *cannot accept* the change made in the duration of the daily burning. In the article criticised, it was a question of one 6-candle lamp burning *twelve* hours daily; now, the daily burning of the 6-candle lamp is *nine* hours only. With a special thermopile, wonderful lamps, marvellous accumulators, and a serious reduction in the daily burning, M. Maier has given to-day numbers consistent and coherent; but those which we criticised were inconsistent, incoherent, and of the *perpetuum mobile* kind.

The person responsible for the remarks in the ELECTRICAL REVIEW can assert, without any special experience with the Gülcher thermopile, that the numbers given by M. Maier in his former article are without foundation, and the best proof is that M. Maier has been obliged to alter all of them in this second article, different thermopile, reduction of daily burning, &c.

We have very often discussed technical questions in our electrotechnical life, but the process of argument adopted by M. Maier has been, until now, absolutely unknown to us. *On apprend à tout âge.* THE PERSON RESPONSIBLE.

THE INVENTOR OF THE THREE-PHASE ALTERNATING MOTOR SYSTEM.*

IN a communication which appeared in one of our contemporaries a short while ago, Mr. C. E. L. Brown, the well-known Swiss electrical engineer, in referring to the transmission of power between Lauffen and Frankfort, sought to correct the erroneous impression that the three-phase system was the salient feature of this installation, and pointed out that the principal object of the experiment was to prove the possibility of producing and transmitting high-tension currents over long distances by naked wires suspended from poles, and with such a degree of security against danger and such a small amount of leakage as to demonstrate that this method has a right to commercial existence. The adoption of the three-phase current, according to Mr. Brown, only increased the difficulties to be met, since nearly all the apparatus thereby became more complicated, and the only reason justifying the adoption of the three-phase current was to demonstrate its advantages when applied to several small motors at the same time. The only novelty in the system

* New York *Electrical Engineer*.

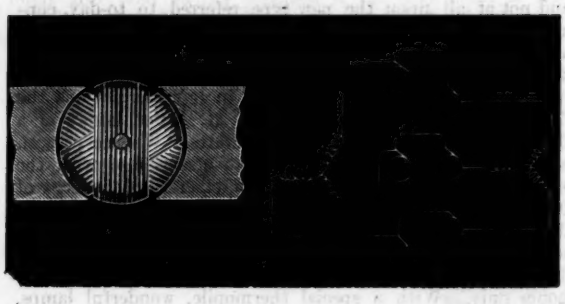
shown at Frankfort were important constructive improvements in its application which Mr. Brown, almost without exception, claimed as his own. Mr. Brown concluded by asserting that the three-phase current as applied at Frankfort was "due to the labours of Mr. Tesla, and will be found clearly specified in his patents."

In reply to the above, Mr. Carl Hering thought that Mr. Brown had not done proper justice to the real inventor of this modification of the Ferraris-Tesla system, namely, Dobrowolsky. Without the *invention* of a new principle or a new modification, the ablest constructor would hardly be able to make any very great departures from well-known systems. Due credit should therefore be given to the inventors as well as the constructors.

In support of the claims made in the concluding paragraph of Mr. Brown's communication, quoted above, that gentleman has asked us to publish the following letter, which explains itself :—

I should like to make a few remarks on Mr. Carl Hering's comments on my letter of the 12th October last.

I would first draw his attention to the concluding paragraph of that letter; and secondly refer him to Mr. Tesla's patents for the three-phase current filed October 12th, 1887, Nos. 381,968 and 382,280, and his further patent No. 390,414, filed April 23rd of the



following year, of the existence of which patents Mr. Hering seems to be ignorant. For his further edification I enclose sketches which are *fac-simile* copies of drawings in the patents above referred to.

I think that he should then see that I have done full justice to the true inventor of the three-phase current system.

C. E. L. BROWN.

Baden, Switzerland, *Jan. 6th*, 1892.

ON THE TELEPHONING OF GREAT CITIES, AND AN ELECTRICAL PARCEL EXCHANGE SYSTEM.

BY the courtesy of the publishers (Messrs. Whittaker and Co.) we have been favoured with a copy of a "revised edition, with notes," of the two above-mentioned papers, which were read by Mr. A. R. Bennett before the British Association, and published in our issue of September 4th. The notes refer to the telephone paper, and we think our readers will be interested in perusing them. In the first column we print in full Mr. Bennett's notes; in the second column will be found the facts :—

NOTES TO PAPER ON THE TELEPHONING OF GREAT CITIES.

Some correspondence appeared in the ELECTRICAL REVIEW during October and November, 1891, consequent on an adverse criticism of this paper, which was published in that periodical on September 11th.

The ELECTRICAL REVIEW article, a second which followed on October 2nd, and a concluding one on November 13th, together with the letters of the only two correspondents who sided with the ELECTRICAL REVIEW constitute what may fairly be described as a curiosity in technical criticism.

The articles, generally speaking, betrayed but very hazy notions of practical telephony,

at least of a more recent date than 1881 or 1882,

and were palpably designed to justify the existing London Exchange system.

The untenable position was assumed that the existence of the "Mann" system in any town had the effect of isolating that town from trunk communication with others, unless they too adopted it. Subsequently, in face of the opposition excited, it was admitted that trunk communication was not rendered impossible, but only *difficult!*

The ELECTRICAL REVIEW consequently stands pledged to the proposition that two bad systems, when joined by trunk lines, work better together than one good and one bad, which is absurd.

The first and second articles were contradictory in some important respects,

and the lack of practical knowledge on the part of the ELECTRICAL REVIEW was so great, that when Mr. J. D. Miller wrote demonstrating, to his own satisfaction, that such a switchboard as the Mutual, as described in the paper, was an impossibility, the ELECTRICAL REVIEW thanked him in a footnote for what it was pleased to designate his "interesting letter," and his "facts and figures." Unfortunately it had not noticed, as any expert would instantly have done, that Mr. Miller had written under the impression that a *square foot contains only twelve square inches!*

In his next letter Mr. Miller fell into further arithmetical inaccuracies; but it was reserved for the ELECTRICAL REVIEW itself to cap the edifice by calmly demonstrating anew, on November 13th, the impracticability of the switchboard, this time on the assumption that *square inches are identical with inches square!*

The first letter appeared on September 11th, consequent on the paper, and not the criticism.

The article of October 2nd was not a criticism of the paper, but a complete reply to Mr. Bennett's letter published on the same date.

The weight of evidence is not to be ascertained by counting witnesses.

An expression of Mr. Bennett's opinion.

The "notions" were not "hazy." Different observers may consider them right or wrong, but they were distinct.

Mr. Bennett's main plans dated from 1879 and 1880.

ELECTRICAL REVIEW, October 2nd (p. 378): "We have no reason whatever to criticise Mr. Bennett on other than the broad grounds of reason and of right."

We did not say that it would be "impossible." "Difficult" was the word originally used and not "subsequently admitted." The word "isolated" was used. It was not a good word. It would not have been used if we had known that it would have been isolated from its context in the endeavour to pervert our meaning. Fortunately, however, under the circumstances, we accompanied "isolated" with an illustrative remark which showed our meaning. It was fully explained on October 2nd (p. 379), where will also be found

the proposition to which we stand pledged. It is "the broad principle that inter-communication is facilitated by similarity and rendered more difficult by dissimilarity, of systems." Mr. Bennett's representation of our proposition will be seen to be a misrepresentation and an absurd one.

We presume that in his letter published October 9th (p. 435), Mr. Bennett did not omit to mention any "important" instance. In a note to that letter, we showed that none of the contradictions existed, but that they were manufactured by Mr. Bennett, with the assistance of partial extracts carefully removed from their qualifying contexts.

We did not thank our correspondent for his facts and figures. We (October 16th, p. 463) *thanked* him for his *letter* and *expressed our satisfaction* at the welcome *contrast* between it and some other letters, in that it *gave us facts and figures;* to which remark we adhere. We commented only on those points in which our correspondent differed from us. The figures referred to a point which we had not raised, and they were not accepted, adopted, or examined, much less "approved" by us, as Mr. Bennett states. The ability to discover the error is not limited to an expert. It was made by one expert, who corrected it and apologised to our readers for it. Other mistakes of a less excusable kind have been made by another expert without correction or apology.

ELECTRICAL REVIEW, November 20th, p. 604. "Erratum: We regret that in quoting from Mr. Bennett's paper we inadvertently printed on p. 560 of our issue of November 13th, first paragraph, '5¼ square inches,' instead of '5¼ inches square.' The correction affects the comparisons on lines 7 and 14. As printed in our article, these do not represent the comparison in Mr. Bennett's paper, which was '9·9 square feet,' and '5¼ inches square.' *The purport of the paragraph is not otherwise affected, as our statements and comparisons are correctly based on inches square, and not square inches,* as printed in error." It will be seen from this that the assumption of any such identity as that stated was distinctly controverted. Our remarks had nothing whatever to do with proving the impracticability of the switchboard. They had to do with proving the inaccuracy of Mr. Bennett, and they did it.

The real and imaginary dimensions are contrasted in the following figures:—

18$\frac{3}{16}$ in. square = 330·75 sq. in.
Mr. Miller's idea, approved by ELECTRICAL REVIEW, 12 times (approximately) too large.

5$\frac{1}{4}$ in. square = 27·5625 sq. in.
Real size, as described in Paper.

5 square inches.
ELECTRICAL REVIEW's last idea, 5$\frac{1}{2}$ times (approximately) too small.

The ELECTRICAL REVIEW closed the correspondence on November 20th, declining to insert a letter calling attention to its last astounding blunder.

The author avails himself of this opportunity to apologise to Major-General Webber for the statement contained in the opening paragraph that the problem of telephoning great cities had never yet been seriously faced. Just before the paper was read, the author was made acquainted with the fact that Major-General Webber had, some years ago, in a communication to the Society of Arts, discussed the problem of telephoning London, and proposed to solve it by the adoption of multiple switch-rooms, much in the manner recommended in the present paper.

An error which had inadvertently crept into the Appendix is corrected in this reprint, as are also a few unimportant slips in the diagrams.

The dimensions represented by the first figure were *not* "approved" by us; the "idea" represented by the last figure was *not* our idea (see erratum above); and the dimensions represented by the middle figure are *not* the "real size, as described in paper," where it was said (Sept. 4th, p. 277), that 5$\frac{1}{4}$ inches square was the space required for 100 subscribers. We said (Nov. 13th, p. 560) that 5$\frac{1}{4}$ square inches (corrected to inches square) did not represent that space but did represent a block of 100 contact points, and that they would need to be spread out to about the same length as the other comparison. The paper did not contain a description of the switchboard. One has since been published in a book which we have reviewed:—(Practical Telephone Handbook, pp. 180, 181.) "The sockets are made up in groups of 100 . . . 5 inches square . . The sets of 100 . . . are fixed horizontally . . . in a long table . . . 28 inch wide . . . , each hundred is multipled or repeated along the table about every 5 feet." In 5 feet of length two to three operators could be placed. The two sides of the table would accommodate four to six operators. Each operator has 60 to 100 subscribers (Paper Sept. 4th., p. 276). Four with 100 each or 6 with 66$\frac{2}{3}$ ("approximately") each would show the table to accommodate 400 subscribers. The space, therefore, occupied by 100 subscribers is one-half of 5 feet by one-half of 28"; or 30" × 14" equal to 420 square inches, or 20$\frac{1}{2}$ inches square instead of the "5$\frac{1}{4}$ inches square" of Mr. Bennett. The otherwise useless figures may be utilised for showing that the *real* space is larger than that represented by the first figure, instead of being identical with that of the middle figure.

The correspondence was closed, Nov. 13 (page 558).

ELECTRICAL REVIEW, Nov. 20 (page 604):—"Mr. A. R. Bennett. The correspondence is closed. We thank you for calling our attention to the error, which we have corrected." The correction preceded this as above quoted.

ELECTRICAL REVIEW, Sept. 11 (page 305):—"We are sure that the problem is one which must have engaged the attention of every telephone engineer who has a large exchange under his charge, and who finds it, from his daily experience, one requiring serious consideration, and not too confident assertion of the success of any solution which he may propound without the confirmation of experience."

Major-General Webber's paper was a very important contribution to the technical literature of the subject at the time it was read. We quoted it for the purpose of showing that the reasons for the adoption of multiple switch-rooms, "much in the manner recommended, &c.," have been demonstrated by experience to no longer exist.

The important errors in the paper proved conclusively by us remain, then, uncorrected.

The Leeds Corporation and the Electric Light.—A meeting of the Sub-Corporate Property (Corporate Buildings) Committee of the Leeds Corporation was recently held. It was resolved, says the *Leeds Mercury*, to recommend the council to put a fresh installation in the Free Library, and overhaul the existing installation in the rest of the building and the Town Hall. All the other parts were in good order. Mr. Nichol, of the Borough engineer's office, was appointed to superintend the work, subject to the confirmation of the council, which it is estimated will cost about £500.

PROF. FORBES ON THE DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.

THIRD CANTOR LECTURE.

PROCEEDING with the third lecture, Prof. Forbes thought it was impossible to speak on electricity at the present time without making some allusion to the remarkable lectures of Mr. Tesla, particularly as they had some bearing on a certain part of the subject dealt with in the present Cantor series.

THE PRACTICAL MAN.

Before going further, the lecturer satirised the person who called himself a practical man. One of the technical journals, he said, remarked that after the brilliant lectures of Wednesday evening, the practical man asks what the experiments will lead to. If a man, said the Professor, called himself practical, he would advise him to leave Mr. Tesla's experiments alone, for that "man" was hardly in the position of being able to appreciate at their true value the experiments which were performed. He hoped the time had come when those who had been in the habit of arrogating to themselves the title of "practical," would cease to do so. Men who applied that term to themselves, did not realise the self-sufficiency shown by their taking such a title. It was the highest praise which could be bestowed on the best engineer. He that usually assumed the term, was the man who could use his hands, but could not use his head; the man who could not apply theory in order to interpret a formula; the man who could attend to a well-known type of engine, but who would be unable to appreciate the progress made in the ten years since Parsons turbines existed. Great men did not speak boastfully of themselves as practical men or geniuses; their Watts, Rennies, Bakers, did not say they were practical men, but they were proud to become so. After this severe handling of the poor British workman, the lecturer proceeded with the remark that Mr. Tesla's work, to the engineers, and to the natural philosophers, was of the greatest importance, for they were shown the difficulties which had troubled them in the past, and thus engendered hope for the future. The difference between the natural philosopher and the engineer, was that the former only claimed to be nature's pupil, the latter aimed at being her master. In Mr. Tesla's experiments, the engineer saw difficulties explained and partially removed; he saw the things that had puzzled him in the action of the alternating currents, and of air condensers. The engineer also saw that Tesla had worked out a system of electric lighting, producing a more pleasing sight than they had seen before, and by means which were almost in a practical shape. The natural philosopher, on the other hand, saw explanations for a vast number of the experiments which had puzzled him in the past, and saw new developments, new experimental investigations, which would lead to a better knowledge of the structure of matter. "Mr. Tesla strives to-day as the philosopher; to-morrow he will triumph as the engineer," said the lecturer. The remarks which he had made would lead them to suppose that he placed great importance on what Mr. Tesla had said about the construction of mains. They had long noticed that when an alternating current of high potential and frequency was passing through a wire, a light was often seen to come from the posts on which the wires were supported. That fact was particularly noticeable in the experiments which were conducted at Frankfort last year, when a large amount of power was transmitted over a distance of 112 miles. They were then at a loss to completely understand the action which was going on, and how to overcome it. Mr. Tesla had given an answer to both, and by going to these high frequencies he had exaggerated the difficulties, and thereby enabled them to see the meaning of them in the more moderate pressures and frequencies used in actual practice.

OIL AS AN INSULATOR.

There was little doubt that Mr. Tesla had given them the right solution of the enormous value of oil as an insulator in all these cases, and it could not be too strongly impressed upon engineers the importance of oil insulation for cables which were carrying high tension currents over long distances. They had known the value of oil as an insulator,

but had never previously realised the enormous importance of it. The insulation introduced by Mr. Brooks, which no doubt would be largely used in the future, was extremely valuable for alternating current and for the low tension distributing mains. The lecturer here briefly described the advantage of the Forbes system of mains.

QUESTION OF POWER AS APART FROM LIGHT.

There were two totally distinct questions in connection with power used with electricity, the distribution and the transmission of power, which were often intermingled, and the engineer had often to consider the two together; but they were often completely separate, and different demands necessitated the employment of different apparatus. He would give an example which showed how greatly the cases were different under special circumstances. Much had been said about the employment of the Falls of Niagara for conveying power to a distance. It was originally suggested by Siemens and Thomson to carry the power from Niagara into New York, and lately the problem had been presented of carrying the power to the manufacturing centre of Buffalo, a distance of 30 miles. In either of these cases the great problem was the transmission of power; to distribute it through the town was not of the same importance. To devise means, therefore, to carry the power from Niagara to Buffalo was the solution of a very great problem. On the other hand, if they were to take the case of a power station situated in London, say, in Clerkenwell, where an enormous number of steam engines are used in small workshops, there could be no place more suitable for putting down a power station, but the demand would be totally different. It would not be sufficient to simply generate power in one station and then supply it to the motors in the houses to keep them always going. These motors in the workshops required to be stopped and started at frequent intervals, whereas in the transmission question they always required to be stopping motors. That introduced a very great difficulty, because the motors available were incapable of starting frequently every few minutes, for instance, to work a lathe, and therefore for the distribution of power they must have special kinds of motors capable of starting frequently with the greatest ease. When transmitting power to great distances, it was perfectly obvious that they would be obliged to use high pressure, whether continuous or alternating. They never wished to use a higher pressure than was absolutely necessary, because it was always a disadvantage, and the difficulties and dangers were increased when they went to higher pressures; they wanted a pressure as low as possible to make the thing a commercial success. Sir William Thomson, in 1881, laid down a general rule for the economy of conductors. Summarised in its simplest form, it amounted to this: That the interest on the capital invested in copper should be equal to the energy which was being wasted in the mains. Some years ago, Prof. Ayrton read a paper before the Institution of Electrical Engineers, in which he considered Sir William Thomson had made a mistake in this law, when applied to such a case as carrying current from Niagara to New York. The whole of the mathematics by which Prof. Ayrton supported this argument resolved themselves into this: The cost of the energy which you have to take into account is really partially dependent upon the amount of copper you put down; that is to say, the further the distance off from your generating station, the greater is the cost of copper, and therefore the greater is the cost of the energy, so that when you go to far distances you have to allow for a greater cost per horse-power hour than you would have done if you were not going to so great a distance. This is the whole of the "mare's nest" that Prof. Ayrton thought he had found as a flaw in Sir William Thomson's arguments. He, the lecturer, pointed this out to the gentleman who gave some lectures on transmission of power at the Society of Arts not long ago, but he slightly misunderstood the explanation. He stated that we had to consider, as the cost of energy, the cost which that amount of energy would fetch in the market, and that since the energy was more valuable at New York than at Niagara, therefore they had to add to the cost of the energy. In all those cases which came before the engineer for transmission of power to distances, the only really satisfactory way of applying the principle of Sir Wm. Thomson's law was to work out the results at several different densities of current; that, of course, involved considerable work. They must take, in the first place, approximate figures, and assume different pressures of electric current, a thousand volts, five thousand, and ten thousand, and work out the cost of sending power at all these different pressures, and densities of current in the conductors. That was the only way by which they could arrive at the greatest economy. It was easy, because it was only when they came to the final results that one needed accurate figures. An important question in transmission of power was the kind of apparatus to be used. Were they to use continuous current—granted, of course, that they were to use high tension—or alternating currents. Two years ago, if this question had been asked, it would have been found that nine men out of ten would have answered that there was no other means than the continuous current. In fact, at the time when the question of transmitting power from Niagara was under the consideration of the commission which sat and considered the different proposals, they as nearly as possible passed a general resolution, for the guidance of the syndicate which had the concession, that it was impossible to use alternating currents for the purpose, and yet within this short space of time what a transformation had taken place. He, the lecturer, supposed it was mostly due to the extremely interesting experiments carried out at Frankfort than to anything else that such change of opinion had come over men's minds. If the question of continuous and alternating currents were to be asked at the present time he would doubt very much whether one in ten would advocate the continuous current. He did not wish to undervalue the capabilities of the continuous current for transmitting power of high pressure, for he had known cases where it had been successfully done, and with proper precautions he felt sure that it could be done well. The machines which can be used for alternating currents were enormously varied in character. First, however, he would speak a few words about continuous current motors with a commutator. In the case of using an alternating current it was essential to have the field magnets made with laminated iron, in order to prevent Foucault currents in the iron of the field magnets. Even then the machine would not work with an alternating current of high frequency, but doubtless in the future they would have much lower frequencies and with such low frequencies the continuous current motor would work extremely well. As he had said before, an ordinary continuous current laminated motor for 100 volts would, owing to the self-induction of the circuit, when using an alternating current, give an efficiency of only 50 per cent., 100 extra volts being required for the self-induction, whereas if they reduced the frequencies down to the ordinary frequency of a continuous current machine, they would require only six extra volts, and they might say that this was within the range of practical working. For distribution in towns, a motor used with alternating currents would be most desirable. The very fact of having a large current going through the motor magnetised the field magnets and increased the torque. That was a particularly desirable thing in the case of machinery in shops, but it was also of the greatest importance in the case of tramcar motors. All tramcar motors used continuous current motors, but if they were to use alternating current it was quite probable that at the present moment that type of motor would be the most suitable and more readily available. It was in working tramcars and electric railways that they found that tremendous want in the starting torque. This was a case where the value of a series-wound continuous current motor was very great, and the advantage would be reaped by the same type of motor used with alternating current. He had spoken about the possibility of using alternating current with electric railways and tramways. It might be said that there was no advantage in using alternating current for that purpose; but when they came to examine the practical cases which were before them in the City and South London (and the proposed Central London), where they carried a continuous current of 500 volts along some miles of conductors, there was an enormous loss in the leads, and an enormous expenditure on copper.* If they were able to carry alternating current by means of high

* If Prof. Forbes is speaking of the working conductors, we may mention that they are of channelled steel.—EDS. ELEC. REV.

tension over these long distances, and to transform it to the required pressure at the place required for the tramcar and the locomotive, they would gain a great advantage over continuous current. It was extremely probable that alternating current would be adopted in some of the electric railway schemes which had been suggested, and if alternating current were used he considered it extremely likely that a very low frequency, alternating five or ten times per second, with continuous current motors would be adopted, that, at the present, might perhaps be the best method, but it might be quite different in a few months' time. He would call the attention of his auditors to a machine which had attracted considerable attention in the past, the synchronising alternate current motor. It was simply an ordinary alternating current dynamo machine, which also worked as a motor. It was necessary, however, for it to go at the same speed of revolution as the generator of the electricity, otherwise it would not work. It had been a puzzle to a good many engineers, certainly to the practical man he had spoken of, why some alternate current dynamos worked better as a motor than others, and this had been rendered a little more puzzling by the explanation given by Dr. Hopkinson, who showed that the self-induction which was produced prevented two alternating current machines (one acting as generator, the other as motor) from getting out of step. As soon as these facts were established, a number of the so-called practical men immediately set to work to make machines with as much self-induction as possible, and altogether defeated their own ends. Great was the astonishment of these men when Mr. Mordey showed that his dynamo machine, which had small self-induction and no iron in the rotating armature, worked most admirably as a motor. The puzzle was complete when a comparison was made with the Siemens, Ferranti and Mordey alternators; the only difference between a Siemens or Ferranti and the Mordey, was that in the one case the armature revolves, and in the other case the field magnets revolve. Yet the Mordey alternator acts as a motor, and Siemens does not. The reason was, simply, that the power which was given to the alternating motor was of a pulsating character, and there were moments when no power was given to the motor at all. If then the motor was doing work, it required to have considerable momentum to get over the dead centres, when no power was given. The Mordey machine, owing to the rotation of the field magnets, had an enormous momentum, and in the Ferranti, with the armature revolving, there was little momentum; that accounted for the Mordey machine working well as a motor, and the Ferranti not doing so. The lecturer then detailed another method of placing two machines on one shaft, which carried each other over the dead centres. After some further remarks on the rotating phase motor, the lecturer pointed out the Ferranti safety earthing device, which he had omitted to show at the last lecture. In the case of a house developing an earth at any part of the circuit, the secondaries not being equalised, the fuse would be melted, and the circuit closed.

NOTES.

Proposed Electric Lighting of Burnley.—For some time past, says the *Burnley Express*, the Gas Committee of the Burnley Corporation have had under consideration the introduction of electric lighting into the town. A canvass has been made of all persons likely to become consumers, and as the result has been satisfactory it has been decided to engage an electrical engineer, with a view to advising the Corporation as to the best system to be used.

The Bournemouth Town Council and the Electric Light.—The Bournemouth Town Council, at a meeting last week, resolved on the proposition of the Mayor, that application be made to the Board of Trade for a provisional order to authorise the council to supply electricity for the purpose of lighting the pier, pleasure grounds, municipal offices, and other public and private places. The intention of the council in drafting the application, and using the words "public and private places" had sole reference to the pier and pleasure grounds and the offices and yards.

The Bahamas—Florida Cable.—The final splice on this cable was made on the 4th inst., and these islands are now in telegraphic communication with the outer world, much to the satisfaction of the inhabitants, if one may judge by the space the subject occupies in the local journals, wherein the cable, and the movements of the ss. *Westmeath* are almost the sole topic. Messrs. W. T. Henley's ss. *Westmeath* left the company's works, at North Woolwich, on December 26th last, and with the exception of a vexatious delay at the start, occasioned by dense fog, has performed her task without a hitch. Complimentary telegrams were exchanged between the contracting company and the Governor. The total length of cable is 213 knots, plus some few miles of land line. There are four types of cable, as follows (the core throughout being 107/140 G.P.):

Main cable	...	sheathed with	16	No. 13	gal. wires.
Intermediate	"A"	"	12	No. 8	"
"	"B"	"	12	No. 5	"
Shore end	...	"	12	No. 1	"

We congratulate Messrs. Henley on the successful laying of this second colonial cable, within 18 months of the completion of the Halifax and Bermuda cable. The company is now engaged upon an extensive order for submarine cables for the Post Office, and their works present a very busy appearance.

Proposed Waterloo and City Railway.—The parliamentary estimates for the construction of the proposed underground railway from near Waterloo Station to Mansion House Street have been duly deposited by the promoters. These estimates set out the length of the line as 1 mile, 4 furlongs, 6·80 chains, and the total cost of construction at £499,769, or at the rate of about £333,178 per mile. Of this sum it is estimated that £144,300 will be required for the acquisition of land and buildings. The cost of tunnelling is set down at £208,615; of the erection of stations at £66,500; and for general contingencies a sum of £46,365 is allowed. These estimates are signed by the same engineers as for the Baker Street and Waterloo railway scheme—namely, Messrs. Galbraith and Church, and Mr. J. H. Greathead.

Half Truths and Whole Truths.—The following extract from Wednesday's *Daily Graphic* will show how careful one should be when dealing with figures. "The present price of electrical energy is dependent on the cost of distribution, not of production, and this diminishes with the amount of supply. Hence, as the output of our central stations is increasing, so the cost per unit sold is diminishing, and one of our metropolitan companies has already declared a dividend of *ten per cent.*" Now 99 persons in 100, reading this passage, would conclude that it meant 10 per cent. per annum, but the whole truth is that the company for which this reference is evidently intended paid an interim dividend of 7 per cent. for the half year ending June, and 10 per cent. for the six months ending December, making 8½ per cent. per annum, an excellent result truly, but not so good as would be inferred from the above extract.

Proposed Railway from Waterloo to Baker Street.—The parliamentary estimates for the construction of the proposed railway from Waterloo to Baker Street have been prepared in accordance with the standing orders of the House of Commons. These estimates, which are signed by Messrs. Galbraith and Church, the engineers to the London and South Western Railway Company, and Mr. J. H. Greathead, the engineer to the City and South London Railway, set down the total cost of constructing this line, including £32,000 for contingencies, at £990,000, or at the rate of just under £330,000 per mile, the total length of the proposed railway being 3 miles, 6 chains. The cost of the actual tunnelling is estimated at £438,435, including the tunnel under the river Thames, near Hungerford Bridge. The erection of the stations will absorb £189,500, whilst laying down the permanent way is estimated to cost £5,000 per mile. The railway for its entire length will be constructed underground.

Erratum.—In our article on Electrotechnics last week for "nationalisation" of labour, read "rationalisation."

Electric Search Lights on the Welsh Coast.—Referring to our recent note on this matter, we learn that the Trinity House authorities are at present considering the advisability of placing a couple of electric search lights on the Welsh coast between Mumbles Head and Worms Head for the benefit of navigation in that locality.

The Bradford Central Station. — The satisfactory result of the last half-year's working of the Bradford Central Station is sufficient to settle the frequently expressed doubts of the ability of the County Council to supply electricity with commercial success. The undertaking has from the outset met with considerable opposition, and in face of the adverse criticism it has been no easy matter to popularise the electric light. As will be gathered from a report in another column, a profit of £971 has been made on the half-year's working, which clears off nearly half the deficit on the previous working. One may expect, judging from the progress made, that the Council will in the next six months clear off the whole of this deficit, after which time a reduction in the price will, no doubt, come. The price at the present moment is 6d. a Board of Trade unit, and as the Council do not work the installation for a profit, the electric light customers will, perhaps, be soon in the enviable position of obtaining the cheapest supply in England. But the report seems to contain some serious blunders, or Alderman Priestman's remarks have been very much misunderstood by those who took shorthand notes of what he said, although a second report sent to us from another source contained the same errors. Surely the cost per unit comes out a little more than one halfpenny for coal and not 12·58d. as stated. Again, if Mr. Priestman will divide 1,000 by 746 he will at once find that the unit is approximately $1\frac{1}{3}$ horse-power, and as for arriving at the resistance in the mains, he has only to ask the electrical engineer in charge, and it will at once be a known quantity even to Mr. Priestman. The report, however, seems generally to have been so badly reported or transcribed, that we cannot fairly comment upon the question of cost until correct figures are to hand.

Glasgow Town Council and Electric Lighting.—We understand that at the last meeting of the Glasgow Town Council it was resolved on the recommendation of the Special Electric Lighting Committee that the business, heritable property, plant and machinery belonging to Messrs. Muir, Mavor, Coulson & Co., should be acquired by the Corporation at the price of £15,000, the Corporation to receive possession on March 1st next.

Lightning Conductors.—The *North British Daily Mail* states, though lightning is frequent in France, conductors are a comparative rarity. In the City of St. Etienne, with a population of 135,000, there are not a score of them, and the few that do exist are of obsolete construction and practically useless.

Electric Lighting at Pontypridd.—A fully attended meeting of the Pontypridd Local Board was held last week for the purpose of considering what steps should be taken with reference to the public lighting of the town. It was decided to let the matter stand over for a little while, so as to enable the clerk to write to Taunton and make enquiries as to the success or otherwise of the electric light in that town. A resolution was then passed in regard to the holding of a special meeting to consider the question of public lighting.

The Electric Light at Fareham.—In the Hampshire market town, where an electric lighting company is in active work, the notice of intended application by the company for a provisional order has aroused the opposition of the Local Gas Company.

Inverness and Electricity.—The proposal to light Inverness by electricity it seems has been knocked on the head for the time being. The enquiry cost £143. At the same meeting it was resolved to extend the gas works at an estimated cost of £9,800.

Ipswich Lighting Order.—We understand that the Electric Lighting Order, 1891, granted to Messrs. Laurence, Scott & Co., has been withdrawn at the promoters' request.

Overhead Wires in New York.—During the past year 5,224 street poles, and 7,152 miles of wire, have been removed and placed underground in New York.

Telephonic.—The National Telephone Company are just completing a new switchboard for the accommodation of 100 additional subscribers in Hillhead, Glasgow.

Electric Lighting at Blackburn.—The Blackburn Corporation have commissioned Mr. Barton, electrical engineer, to map out a large central area for illumination with electric light. The Corporation Parliamentary powers expire in August next, and it is intended to have at least 2,000 lights going before then. The magnificent installation in the Technical Schools, which cost £2,000, was used for the first time last Friday.

Electric Lighting at Heckmondwike.—We understand that the Electric Lighting Committee of the Heckmondwike Local Board have approved of a specification prepared by Mr. W. B. Hutchinson, C.E., for the lighting of the central part of Heckmondwike by electricity. The system to be adopted is the low tension continuous current, and the distribution is to be on the overhead three-wire system. It is proposed to replace each Bray's gas burner by two 32-C.P. lamps.

An Electrical Exhibition at Stuttgart.—A small electrical exhibition is at present being held in the Landesgewerbe Museum, in Stuttgart, and will remain open for a few weeks. The exhibits comprise power transmission plants and various systems of electric lighting.

Telegraphs in Persia.—The telegraph line to Daraguz has been completed. The line to Birjand, which would be of great service, has not yet been commenced.

The Electric Light in the Canary Islands. — A scheme has been drawn up by La Compagnie Edison, of Paris, for the electric lighting of Las Palmas, Canary Islands.

The United States Navy.—The Norfolk navy yard is to be fitted with the electric light. The contract has been secured by the Thomson-Houston Electric Company.

Telegrams for Ecuador, Bolivia, Chili, and Peru.—The *London Gazette* states that the rate for telegrams to all places in Ecuador, Bolivia, Chili, and Peru, by the routes of the Anglo-American, Direct United States, Paris and New York, Western Union, and Commercial Cable Companies, is now 7s. per word.

The Electric Light at Hawick.—The Hawick Town Council on Monday night commenced an experiment, to continue three months, by lighting the High Street by electricity, the work having been carried out by Messrs. Mayor and Coulson, Glasgow. If the experiment is successful, the corporation intend lighting all the streets of the town electrically.

Gas and Electric Light.—We should like to call attention to a point in the lecture which we publish on p. 206. It is that the average consumption of coal per horse-power hour in central electric light stations is $2\frac{1}{2}$ lbs. Surely the author must have very much underestimated the real amount, and if that is so, his deductions are incorrect. Nevertheless, the other facts put forward are very encouraging to the electric light interests.

The Electric Light at the Italian-American Exhibition at Genoa.—As we recently stated, the electric lighting contract for this exhibition has been awarded to Messrs. Schuckert & Co., of Nuremburg. We now learn that the contract includes 145 arc, and 160 (?) incandescents, together with the necessary electric apparatus for the luminous fountains, and a large lighthouse light, similar to that at the recent Naval Exhibition in London, with an illuminating power of 120,000 candles.

Electric Light for Islington.—It is expected that Islington will soon follow St. Pancras by introducing the electric light into some of its principal thoroughfares, the vestry becoming the undertakers. It now costs £16,000 a year for the public lighting of the parish, and the advocates of electric light contend that they offer at half the money a far better system of illumination. The whole question has been referred to a special vestry committee of 20.

Synopsis of the History of Ozone.—We would draw the attention of our readers to the interesting articles appearing in our columns under the above heading. They are by Mr. E. Andreoli; and form the abridged index of a book on Ozone which will shortly be published in French by the writer.

Accumulator Cars in Paris.—What is termed the first serious trial of accumulator cars in Paris is reported as about to be made by the Societe des Tramways de Paris et du departement de la Seine. If the experiment is successful, other companies propose to adopt the system, whilst new lines for the construction of which concessions have been granted will probably be similarly equipped. The first line of the Paris Company on this method is to be in operation between Saint Denis and the Madeleine, and the cars are to attain a speed of 7½ miles an hour normally in Paris, 10 miles outside the fortifications, and 22 miles an hour if necessary! The cars to be used may be characterised as locomotives, as they will only contain the storage batteries, the motors and the driving mechanism. This type of car is the patent of the firm of G. Averly of Lyons, and each axle is fitted with a motor of 15 horse-power. The motors are of the Gramme or Siemens type. The cells are of the Laurent-Cély Sarcia make. One of the peculiar features of the cars is the arrangement of suitable mechanism which permits of their being derailed and placed on the line again according as may be desired. The cars, which will shortly be put into service, are provided with electric brakes, and the weight of one locomotive with two trailing cars is 12 tons.

The Proposed Hampstead, St. Pancras, and Charing Cross Railway.—The promoters of the proposed Hampstead, St. Pancras, and Charing Cross Railway scheme have deposited the Parliamentary estimates for the construction of this railway. The total cost of constructing this railway, with all subsidiary works, is estimated at £1,255,815, of which £1,030,656 is for the main line from Charing Cross to High Street, Hampstead; £185,809 for the short line from under the Hampstead Road to the King's Cross station of the Great Northern Railway; £7,150 for the subway under the Strand to connect with the Charing Cross station of the South Eastern Railway; and £2,200 for a bridge for foot passengers between St. Pancras and King's Cross stations. The railway, if sanctioned, is proposed to be constructed in two separate tunnels, one for up and one for down traffic, and of the total cost it is estimated that £729,860 will be expended in the actual tunnelling. The acquisition of land and buildings will, it is estimated, cost £240,000, the construction of stations £107,100, and for general contingencies a sum of £118,170 is allowed.

Electric Lighting of Dublin.—At last week's meeting of the Dublin Corporation, the Town Clerk was directed to convey to the Electrical Engineering Company the desire of the Corporation that all their material, as far as possible, used in the city electric light works should be procured in Ireland.

Execution by Electricity.—McIlvaine, the man who murdered a grocer named Luca, at Brooklyn, while robbing his residence, was executed by electricity at Sing Sing Prison last Monday morning. The apparatus worked without the slightest hitch, and death was instantaneous.

The Electric Light at Portsmouth.—The Town Council having adopted Professor Garnett's scheme for lighting a large district, including the sea front at Southsea, the electric lighting committee will take prompt action. The site of a large music hall in Gunwharf Road, which was destroyed by fire little more than a year ago, has been acquired for the central station.

The Electric Light in Germany.—Messrs. Schuckert and Co., of Nuremburg, in Germany, have drawn up a scheme for the electric lighting of the adjoining villages of Maikammer and Diedesfeld, near Neustadt.

NEW COMPANY REGISTERED.

Tavernier's French Patents, Limited.—Capital £1,200 in £1 shares. Objects: To acquire from Alphonse Edouard Tavernier an invention described as an electrical apparatus for the automatic indication of fire and of the rise of temperature in the bearings of machinery, and for simultaneously supplying oil where required, and to work and develop the same. Signatories (with one share each: J. T. Thomson, 116, Neville Street, Stoke Newington, N.; H. P. Sands, 11, Belleville Road, Wandsworth Common, S.W.; W. E. Savory, 20, Tintern Street, Clapham, S.W.; P. V. Hirschfield, 15, Osenev Crescent, N.W.; J. Pearce, Stanhope House, Kenway Road, N.W.; F. Narsey, 84, Church Street, Croydon; H. G. Philipps, 40, Fentiman Road, Clapham Road, S.W. The number of directors is not to be less than two nor more than five, the first to be appointed by the signatories. Qualification, £200. Registered on the 3rd inst. by Williams and Neville, 23, Austinfriars, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Richard Hornsby and Sons, Limited (Mechanical and Electrical Engineers).—The annual return of this company, made up to December 23rd, 1891, was filed on December 30th, 1891. The nominal capital is £400,000 divided into 30,000 ordinary shares of £10 each and £100,000 worth of preference stock. All the shares and stock have been taken up, and upon the ordinary shares £8 per share has been called, while the preference stock has had the full amount called and paid, the amount paid being £340,000. Works, Spittlegate Iron Works, Grantham. London office, 84, Lombard Street, E.C.

Automatic Electrical Corporation, Limited.—The annual return of this company, made up to the 14th ult., was filed on the same day. The nominal capital is £75,000 in £20 shares, and of these, 3,743 shares have been issued as fully paid. The remaining shares have had the full amount called and all calls paid. Registered office, Winchester House, Old Broad Street, E.C.

British Electric Propulsion and Traction Company.—The annual return of this company, made up to September 16th, 1891, was filed on September 22nd, 1891. The nominal capital is £5,000 in £1 shares. Of these, 3,241 have been taken up, and 3,184 have been issued as fully paid. Upon the remaining 57 the full amount has been called and all calls paid. Registered office, 50, Gresham Street, E.C.

Bernstein Electric Lamp Company, Limited.—The registered office of this company has been removed from 2, Marlborough Mansions, Victoria Street, Westminster, S.W., to 40, Chancery Lane, W.C.

British Electric Lighting Company, Limited.—The annual return of this company, made up to the 13th ult., was filed on the 21st ult. The nominal capital is £100,000 in £10 shares. Of these, 8,640 have been taken up, and 1,144 have been issued as fully paid. Upon the remaining 7,496 the full amount has been called, and all calls have been paid. Registered office, 11, Delahay Street, Westminster, S.W.

Crossley Telephone Company, Limited.—The annual return of this company, made up to September 7th, 1891, was filed on September 14th, 1891. The nominal capital is £100,000, divided into 5,000 "A," 12,500 "B," and 2,500 "C" shares of £5 each; 607 "A," 120 "B," and 350 "C" shares have been taken up, the full amount called, and all calls paid. Registered office, Albany Buildings, Market Street, Bradford.

Electric Meter Company, Limited.—The annual return of this company, made up to the 13th ult., was filed on the 21st ult. The nominal capital is £50,000 in £10 shares, of which 2,007 have been taken up, 2,000 have been issued as fully paid, and upon the remaining seven the full amount has been called, and £30 has been paid, leaving £40 unpaid. Registered office, 25, College Hill, Cannon Street, E.C.

Barnet and District Electric Supply Company, Limited.—The annual return of this company, made up to the 12th ult., was filed on the same day. The nominal capital is £5,000, divided into 490 ordinary shares of £10 each, and 100 founders' shares of £1 each. 80 ordinary and all the founders' shares have been taken up, and all the founders' shares have been issued as fully paid. Upon 60 of the ordinary shares the full amount has been called, and upon the remaining 20 shares £5 per share has been called, and £700 has been paid. Registered office, 31, Wilson Street Finsbury, E.C.

British Insulated Wire Company, Limited.—The registered office of this company has been removed from 15, Union Court, Castle Street, Liverpool, to Prescot, Lancashire. (Filed December 11th, 1891).

Clegg's Metal Incandescent Lamp Company of France, Limited.—The registered office of this company has been removed from 1, Wharf Road, City Road, London, to Connaught Mansions, Victoria Street, Westminster. (Filed on the 24th December, 1891.)

Law's Electrical Appliances Company, Limited.—The statutory return of this company, made up to the 3rd inst., was filed on the 5th inst. The nominal capital is £4,000 in £5 shares, of which 793 have been taken up, 786 have been issued as fully paid, and upon the remaining seven no calls have been made. Registered office, 2, Jackson Road, Holloway, N.

LEGAL.

Allison v. City and South London Railway Company. In the action by the trustees of Mr. Spurgeon's Stockwell Orphanage against the Electric Railway Company for what is technically called a "nuisance," arising out of the vibration caused from working the dynamos for generating electricity on the company's premises at Stockwell, adjacent to the Orphanage, and from the condensation of steam, deluging the orphanage windows, Mr. Renshaw, Q.C., counsel for the plaintiffs, on Tuesday last, applied to Mr. Justice Kekewich, sitting in the Chancery Division, of the High Court of Justice, who partly heard the action in June last, and said that as the result of the suggestion of his Lordship on that occasion, the company had made certain alterations with the view of remedying the complaints. The learned counsel read a correspondence which had passed between the parties, the company in July submitting to the plaintiffs what they proposed to do, and asking their assent or suggestions of any alternative plans, to which plaintiffs replied that whilst they were anxious a remedy should be provided at the least cost and trouble to the company, they must carry out any proposed remedies on their own responsibility. The result had been that the company had bricked up the recesses in the engine house; had stopped, along the entire length of the engine house roof, the ventilators in the louvre of the roof facing the Orphanage building; had filled up with solid material the cavities in the foundations of the engine; had removed from the engine house walls, adjoining the Orphanage, the Westinghouse air pumps, which were said to cause considerable noise and vibration; and for the entire length of the engine house on the Orphanage side had constructed a wooden ceiling to the iron roof, a work of great difficulty, in view of its having to be done while the engine and dynamos were running, and the mere dropping of a nail, accidentally, might be attended with disastrous results. His Lordship might remember, the learned council went on to say, that his suggestion of a remedy of the plaintiff's complaints was based on his having to consider three points (1) whether there was a nuisance, (2) whether the company had done all they could to prevent it, and (3) whether they were protected by their Parliamentary powers. The question had now arrived at this stage—that the plaintiffs did not feel themselves able to concur in the suggestion by the company of a joint scheme to be placed before his lordship as settling the action; and the company had suggested that plaintiffs should join with them in agreeing that the place should be inspected by some independent person of eminence, who could inform the Court what the state of things is, and should any difference arise in the selection of such a gentleman, or in framing his instructions, it should be referred to counsel, and, if they could not agree, to the learned judge, if he would kindly undertake it. The attention of the gentleman (the company suggested) should be directed to the questions: (1) If there is now any nuisance, some explanation being given of what constitutes a nuisance in point of law; and (2) whether the company have done all they reasonably can, consistently with the maintenance of their works and the works of their railway, to prevent annoyance by vibration, noise, or steam. The facts should be placed before the Court, and then, if it was found any nuisance existed, the point of law should be argued. This (said the learned counsel) was the present position of the matter, and plaintiffs would be glad of his lordship's directions in respect to it.

Mr. COZENS-HARDY, Q.C., for the company, repeated their desire to meet all the reasonable requirements of the plaintiffs, and said that, after all, he thought it would be found there was really but little or no difference between the parties.

His LORDSHIP said that he had no desire to avoid the responsibility of deciding the case, but he thought it would be better for all parties if a satisfactory arrangement could be arrived at between themselves.

At the conclusion of the conversation between counsel, his LORDSHIP said there were two points to be settled: (1) whether any annoyance is still occasioned to the plaintiffs by noise, or vibration, or other interference with their reasonable comfort; and (2) if that should be answered in the affirmative, whether it can be removed by any modifications or alterations. Having this in view, he thought the parties would do well to agree that a gentleman like, say, Mr. Harris, the partner of Sir Frederick Bramwell, should go to Stockwell and informing himself of the exact state of affairs, be prepared to give evidence when the case came again before the Court.

To this the respective counsel assented, and it is understood the case will be again brought before the Court some time next week.

International Cable Company.—Mr. Justice Stirling on Tuesday last continued the hearing of two summonses: one taken out by the liquidator of this company, asking that two directors (Sir A. Armstrong and Mr. M. Mowat) should repay certain sums which they had paid themselves by way of remuneration, and the other a claim by Sir Alexander Armstrong, to prove in respect of remuneration subsequent to the date up to which they had paid themselves. On the first summons, his Lordship said he would give judgment after he had looked at certain authorities, which it would be necessary to comment on in Sir Henry Isaac's case. As to the second claim that might be said to divide itself into three periods. The directors claimed remuneration from March 31st to July 26th, 1890, when the winding up order was made, the petition having been presented on December 16th, 1889. The first period to consider was from March 31st to May 16th, 1889, when a resolution was passed by an extraordinary general meeting altering the articles of association as regarded the remuneration of directors; but as this period would be covered by the decision on the other summons, it was unnecessary to deal with that. The second period was from May 16th, 1889, to December 16th, 1889, when the petition was presented. So far as the claim was made for remuneration as directors it ought to be admitted, as the applicants were properly elected as directors. The third period was from December 16th to the date of the winding-up order. It has been conceded that the whole question was in the discretion of the court, and that *prima facie* the transactions of the company after the commencement of the winding up were void unless the Court otherwise ordered. If services were rendered by the directors between the presentation of the petition and the winding up order, they might be of such a nature that the Court might properly allow them, and to determine this he should direct an inquiry in chambers as to whether any, and what, remuneration should be allowed. The next claim was by Sir Alexander Armstrong for remuneration for having acted as chairman after the passing of the extraordinary resolution until the presentation of the petition; but his Lordship thought Sir Alexander had never been properly appointed as chairman, and, therefore, disallowed the claim.

In giving judgment on Wednesday on the first summons, his Lordsaid referred very fully to the articles of association and also to other authorities on such cases. He considered that if the word "directors" in the articles was to be read with any qualification it should be not "duly qualified" but "duly acting." In his opinion these two directors did "duly act" during the period in question and were entitled to be remunerated accordingly. The summons therefore failed.

Alleged Transfer Forgery.—At the Central Criminal Court, on Tuesday last, William Ralph Vyvyan Hawker, 24, who was indicted for forging the transfer of certain shares in the International Okonite Company, pleaded guilty to a minor count in the indictment.

Mr. Corrie Grant prosecuted.

Prisoner was acting temporarily as the private secretary of Mr. Rawson, of the firm of Messrs. Woodhouse and Rawson. In the name of Mr. Rawson he wrote to Mr. Summers, who was in Paris, and whose duties he (prisoner) was discharging, requesting him to execute a transfer of the shares in question. Having got possession of the transfer, he altered the figures, it was alleged, and deposited it with a Manchester stockbroker as cover. It was stated the prisoner was peculiar in his manner, and he was bound over to come up for sentence.

BUSINESS NOTICES, &c.

Rockhampton and Electricity.—In November, 1889, this company procured an Act of Parliament from the Queensland Government to supply electricity for all public and private purposes within the municipality of Rockhampton, and the Borough of North Rockhampton, and including the bridge over the Fitzroy River that separates the two townships. The company have been carefully

watching the growth of the electric light industry, and issued a circular last November for the purpose of ascertaining what success their installing a central station would meet with. The townspeople have responded so well to this circular that the company have decided at once to lay down a plant for the supply of electricity. For this purpose they have purchased a very central site on which to erect their central station, and the method of supply or distribution will embrace three systems, viz., for 500 yards in each direction from the central station, the system of supply will be ordinary 2-wire distribution at 110 volts. Beyond this area the system will be alternating current transformers, and for the public street lighting (negotiations for which have been opened up with the Town Council), will be direct current series, arc system. The lamps being placed at the intersections of the various streets, the town being laid out on the block system as at Melbourne, and by the same surveyor, the effect should be very pleasing. Thus the central station will be able to supply electricity for all purposes and at any distance. A plant for 1,000 lamps of 16-C.P. for the low tension, and 500 10-C.P. for the alternate current will be laid down at once; among the first consumers being St. Paul's Church to be lighted with eight Brockie-Pell arc lamps of 500-C.P. the Leichhardt Hotel 120 lamps, the Masonic Hall and sundry shops, private houses, &c., making a total of 850 16-C.P. lamps taken up at the present time. The supply will begin about July next. The whole of the work has been planned out, and will be carried out under the supervision of Mr. A. E. Neal, the company's electrical engineer. The company will also carry out isolated installations in Queensland. Rockhampton is situated on the Fitzroy River about 40 miles from Keppel Bay, and just within the tropic of Capricorn. Gas in Rockhampton is from 7s. 6d. to 12s. 6d. per 1,000 feet according to quantity consumed, and for lighting or heating purposes.

Crystal Palace Company.—At the ordinary half-yearly meeting of the Crystal Palace Company, the chairman, Mr. G. T. Rait, remarked in his speech that the Electrical Exhibition, which was nominally opened on January 9th, was really opened last Saturday by the Lord Mayor. It was the greatest the world had ever seen, and he hoped it would reward both the company and the exhibitors for the very considerable outlay they had made. The exhibitors had spent about £16,000. One of the shareholders suggested that a permanent income might be obtained if the directors could make some arrangement for a continuous exhibition of electrical appliances by setting aside a part of the Palace for that purpose, but this opinion did not meet with the approval of the chairman.

Ernest Scott and Mountain, Limited.—This firm are fortunate in being in full work during the present extensive strike on the Tyne, as their men remain at work in all departments. They, however, were the victims of a strike, about a year ago, of a very similar character to that now going on, and which arose from disputes between two classes of their foundrymen, resulting in the entire loss of employment to all the brassfounders in their works, the work being since then satisfactorily accomplished by men brought from other departments, against whose use in the brass works the brassfounders had struck.

Tender Wanted.—Llanelly.—The Llanelly Local Board invite applications for taking over the powers vested in the Board by a provisional order obtained last session of Parliament for the supply of electricity within the district of the borough of Llanelly. Information as to such powers and the area of supply and other particulars can be obtained on application to Mr. John Jennings, clerk, Town Hall, Llanelly. Applications, with terms, to be addressed to the Clerk by March 5th.

Electric Lighting at Aston.—We understand that at a recent meeting of the Aston Local Board it was decided, on the recommendation of the Baths Committee to adopt the system of the electric lighting at the public baths, and to substitute this mode of lighting for gas at the public buildings. It was agreed that the tender of Messrs. Fowler, Lancaster & Co., for the execution of the work at the sum of £1,594, with £30 per annum for the maintenance thereof for five years, be accepted.

The Electric Light in Cornhill.—Several establishments in Cornhill are at present in course of being installed with the electric light. Messrs. Sharp and Kent are fitting it up in the offices of the Union Fire Life Office. Messrs. Paterson and Cooper are carrying out the contract for the Sea Insurance Company, and Messrs. Strode & Co. are fitting up an installation at No. 80, Cornhill.

New Lists.—We have received from Mr. S. P. Wood, of Hull, a copy of his new electrical list for this year. This pamphlet contains prices, illustrations and particulars of dynamos, telephones, electric lighting fittings, electric bells, also batteries, &c., manufactured by the firm.

Tenders Wanted for Telegraphs. — The Direction Generale des Postes et des Telegraphes of France are asking for tenders by the 17th inst. for supplying 87,150 telegraph posts, 538,008 porcelain insulators, 496,500 galvanised iron brackets, and 1,264,000 wood screws.

The Electric Light in South London. — Messrs. Nicholson, Bolton & Tyler, electrical engineers, of 100c, Queen Victoria Street, E.C., are fitting up an installation of the electric light at the Rodney Hotel, Westminster Bridge Road, Lambeth.

The Electric Light in Covent Garden.—Messrs. Verity and Sons, of King Street, W.C., are fitting up an installation of the electric light in the Tavistock Hotel, Covent Garden.

CITY NOTES.

Cuba Submarine Telegraph Company, Limited.

THE directors' report for the half-year ending December 31st, 1891, states that from the accounts it will be seen that the gross receipts (including the balance brought from last account) amount to £21,677 2s. 4d., and the gross expenditure (including the half of the annual payment on account of the 1881 cable) to £6,710 16s., leaving a sum of £14,966 6s. 4d. to the credit of revenue account. Of this the sum of £5,000 has been added to the reserve fund, which now stands at £83,000. The dividend on the preference shares will absorb £3,000, and leave £6,966 6s. 4d., out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income tax, the balance £566 6s. 4d. being carried forward to the current half-year's account. The cables have continued in good working order throughout the half-year. The company's suit against the Spanish Government at Madrid is progressing.

The forty-first ordinary general meeting of the company was held on Wednesday last at the company's offices, 58, Old Broad Street.

Mr. THOMAS GREENWOOD, who presided, said their income had been £350 more than that of the corresponding period last year, while they had saved about £50 in working expenses, which gave them £370 to the good, comparing one half-year with the other. They had taken from the balance £170. These sums together enabled them to put to the reserve fund £5,000, as against £4,450 in the corresponding period of the previous year. They had been enabled to do so, because they had been in the fortunate position of having had no interruption to their cables. Nothing had been spent on repairs. The average amount spent on these each half-year would amount to £3,000, a sum which, though it did not figure in the present, would in some future accounts. He concluded by moving the adoption of the report and accounts.

Mr. ALEXANDER F. LOW seconded the motion.

In reply to questions, the CHAIRMAN said that the 1881 cable was taken on lease from February 17th of that year for a period of twelve years, and the payment of £1,875 for the half-year would expire on February 17th, 1893. It was intended to bring the reserve fund up to £100,000. After it had reached that figure it would be for the board of shareholders to consider, if they were in a position to have £5,000 available, what was to be done with the money. They had for some years been threatened with opposition, but the board were prepared to make a further reduction in their rates if, by so doing, they could ward it off, and preserve their present traffic.

The motion was agreed to.

Dividends at the rate of 10 per cent. per annum on the preference and 8 per cent. on the ordinary shares were afterwards declared.

City and South London Railway.

A POLL of the shareholders in the City and South London Railway was taken on Tuesday at the offices, King William Street, City, on the question of a Bill to continue the existing line from the Monument to a central station at Lombard Street, thence under Moorgate Street to the Angel, Islington, at an estimated cost approximating to £2,000,000, to be raised by the formation of a separate company. The matter was discussed at a special meeting on the 2nd inst., when Mr. C. G. Mott, the chairman, intimated that the retention of his position depended upon the acquiescence in this scheme by the shareholders. The proposal was declared carried; but a poll was demanded, and the chairman announced as the result that the opposition had been practically withdrawn and the Bill was approved.

Liverpool Overhead Railway.

THE seventh half-yearly meeting of the Liverpool Overhead Railway Company was held on Tuesday in Liverpool. Sir W. B. Forwood presided. The accounts showed a net credit balance of £913 7s. 11d., and were adopted. The Chairman explained that the construction of the railway was making rapid progress, and was expected to be ready by autumn. Messrs. James Barrow, Edward Lawrence and G. B. Robertson were re-elected directors. At subsequent special general meetings the directors were authorised to raise £75,000 by the issue of debenture stock, and to promote a Bill for making certain extension railways, &c.

The Northern Electric Wire and Cable Manufacturing Company, Limited.—This company, on Wednesday last, declared a dividend of 7½ per cent. per annum, and carried forward an amount to balance. The company has paid this dividend ever since its formation.

Telegraph Construction and Maintenance. — The directors recommend a distribution of 20 per cent. for the past year, 5 per cent. of which has already been paid.

TRAFFIC RECEIPTS.

The Great Northern Telegraph Company. Receipts in January, 1892, £20,000; corresponding month 1891, £20,800; corresponding month 1890, £19,900.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Feb. 4th.)	Closing Quotation. (Feb. 11th.)	Business done during week ending (Feb. 11th, 1892.) Highest.	Lowest.
250,000£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 — 102	99 —102	...	...
1,300,980£	Anglo-American Telegraph, Limited	Stock	50 — 51	50 — 51	50½	49½
2,849,510£	Do. do. 6 p. c. Preferred	Stock	89 — 90	89 — 90	90	89
2,849,510£	Do. do. Deferred	Stock	12½— 13	11⅞— 12⅛	12⅝	12
130,000	Brazilian Submarine Telegraph, Limited	10	10½— 11	10¾— 11¼	11⅛	10⅝
53,200£	Do. do. 5 p. c. Bonds	100	100 —103xd	100 —103	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3¼— 3½xd	3¼— 3⅜	3⅜	3 5/16
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2½xd	2 — 2⅛	2⅛	2 1/16
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½— 4½	3½— 4½	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3¼	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	6 — 6½	6½— 6¾	6½	6⅜
$7,716,000	Commercial Cable, Capital Stock	$100	153 —157	153 —157	154	153½
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	⅜— ½	⅜— ½	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½— 6	5½— 6	5 13/16	...
16,000	Cuba Telegraph, Limited	10	10 — 11	10½— 11½	11⅛	10¾
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼— 3⅜	3¼— 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	8½— 9½	8½— 9½	9½	9
60,710	Direct United States Cable, Limited, 1877	20	11 — 11¼	11 — 11¼	11¼	11
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 14⅝	14⅜— 14⅝	14 11/16	14¼
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15 7/16	15⅜
200,000£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	105 —108 xd	105 —108	...	...
1,200,000£	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 — 110	107 —110	109½	107½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15½	15 3/16	14⅞
78,300£	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	102 —105	102 —105	...	...
276,200£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	102½	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	...	...
135,000£	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	101 —104	101 —104	...	...
180,400£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	103½	102
201,600£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	98 —101 xd	99 —102	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	6 — 6½	5⅞— 6¼	6⅛	5⅞
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ..	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	2⅛— 2⅜	2⅛— 2⅜	2⅜	2 1/16
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3¼— 3⅜	3¼— 3⅜	3⅛	3
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd,	2	2 — 2¼	2 — 2¼	2 1/16	1 15/16
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅞— 10⅛xd	9⅞— 10⅛	10⅛	9⅞
180,042	Do. do. 6 p. c. Preference	10	14⅝— 15 xd	14⅝— 15	15	14⅝
150,000	Great Northern Tel. Company of Copenhagen	10	19 — 19½	19 — 19½	...	...
220,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	106 —109	103	107½
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7⅞— 8¼	7⅞— 8¼	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	22 — 23	21½— 22½	22⅝	22
200,000£	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	104¼	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	41¾	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	3½— 4½	3½— 4½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	2⅜— 2⅞	2⅜— 2⅞	2⅝	2⅜
10,000	Do. do. fully paid	5	4¾— 5	4¼— 5	4⅞	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9 — 9½	8½— 9	9 1/16	8 13/16
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅛— 4⅜	4⅛— 4⅜	4⅜	4⅛
15,000	Do. 6 p. c. Cum., 1st Preference	10	12¾— 13¼	13 — 13½	13⅜	13 5/16
15,000	Do. 6. p. c. Cum. 2nd Preference	10	11½— 12½	11½— 12½	12¼	12
420,000£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	104 —107	104 —107	105¾	105¼
250,000£	Do. (issued at 5 p.m., all paid)	...	54 — 57	54 — 57	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	1/16— 1/16	1/16— 1/16	...	...
9,000	Reuter's Limited	8	7½— 8	7½— 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8½— 9xd	8½— 8¾	8¾	8½
7,900	Do. do. do. 7 per cent. pref.	5	7½— 7¾xd	7½— 7¾	7 7/16	...
3,381	Submarine Cables Trust	Cert.	116 —121	115 —120	116½	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3½— 4	3¾— 4¼	4	3⅞
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	43 — 45	44½	43½
150,000£	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 —103	100 —103	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	1 1/16	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	80 — 90	80 — 90	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400£	Do. do. do. 5 p. c. Debentures	100	101 —104	101 —104	104	102
30,000	West Coast of America Telegraph, Limited	10	4 — 5	4 — 5	4⅜	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	101 —105	101 — 105	...	...
67,007	Western and Brazilian Telegraph, Limited	15	10 — 10½	10½— 10⅝	10⅝	10 5/16
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼— 6⅜	6¼— 6⅜	6⅜	6 5/16
30,364	Do. do. do. 5 p. c. Deferred.	7½	3⅜— 4¼	4 — 4½	4¼	4
189,700£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	101 —104xd	101 —104	...	...
237,200£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	101 —104xd	101 —104	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅝— 1¾	1⅝— 1⅞	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9½— 10	9½— 10	10	9 13/16
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½— 9½	8½— 9½	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	113 —122	...	...
173,100£	Do. do. 6 p. c. Sterling Bonds	100	98 —102	98 —102	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6½— 7	6½— 6¾	6½	6⅜

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7¼—7⅜.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Halifax and Bermuda Cable, 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 4¼—5.—7 per cent. Preference Shares of £5 (fully paid) 5⅛—5⅜.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5½—6.—Liverpool Electric Supply Shares of £5 (fully paid), 4½—5.—Do. shares of £5 (£3 paid), 2⅜—2⅝.—London Electric Supply Corporation, Ordinary (£5 paid), 1—1¼.—Do. 6 per cent. Preference, 1¼—1⅜.—Manchester, Edison and Swan Company, £9 (£1 paid), ½—⅝.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 103—¼.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 1⅜—1⅝.—£5 Preference (fully paid) 3½—3⅝.—Ward's Electric Car (£10 paid), 1⅜—1⅝.

† Quotations on Liverpool Stock Exchange.

BANK RATE OF DISCOUNT.—3 per cent. (January 21st, 1892).

LONDON COUNTY COUNCIL.

THE ELECTRIC LIGHT IN THEATRES.—COUNTY COUNCIL'S NEW REGULATIONS.

AT the weekly meeting of the London County Council on Tuesday last week at Spring Gardens (Sir John Lubbock, Bart., M.P., in the chair), the theatres and music halls committee submitted an important set of new regulations for places of entertainment.

Mr. R. ROBERTS (vice-chairman of the theatres and music halls committee), in reply to Mr. Fardell (who asked that, in view of the importance of the regulations, they should be taken back for a week to enable the council to fully understand them), stated that he was ready to accede to the request. He added that the main part of the regulations were necessitated by the various methods in use for warming theatres, and by the introduction of the electric light.

The following are the regulations with reference to electric lighting:—

Where the electric light is permitted in such premises, it shall be on condition that a competent electrical engineer do certify in writing to the satisfaction of the council once in six months that the system is in proper working order.

1. All such premises when lighted by electric light shall have at least three separate and distinct circuits (*a*) for the stage (*b*) and (*c*) for the auditorium, corridors and exits.

The circuits referred to in (*b*) and (*c*) shall be so arranged, that half the lights in each division of the auditorium and half those in each corridor and exit shall be on (*b*), and the other half on (*c*) circuit.

When the current is supplied by a public lighting company, these circuits shall be taken separately from the street mains.

Under all circumstances complete metallic circuits must be employed.

Gas and water pipes shall never form part of any circuit.

The number of lamps shall be so sub-divided that no sub-circuit shall carry more than 65 ampères, and each sub-circuit shall start from a distributing board.

2. All conductors used within buildings shall be of copper, having a conductivity equal to not less than 98 per cent. of that of pure copper, and shall be so proportioned to the work they have to do that, if double the normal current be transmitted, their temperature shall not rise to above 150 degrees Fahr.

The conductors shall be insulated with pure and vulcanised India-rubber.

The insulation resistance shall be not less than 300 megohms per statute mile, at 60 degrees Fahr., after one minute's electrification, when tested with at least 400 volts, and after 48 hours immersion in water.

The insulated conductors shall be protected on the outside by stout tape or braiding impregnated with preservative compound.

If it is desired to use any other means of insulation than that above specified, special permission shall be obtained from the council, and no material shall be used which is not waterproof, or which will soften at a temperature below 170 degrees Fahr.

In all cases conductors conveying currents of high electromotive force inside buildings, shall be specially and exceptionally insulated, and cased in, and the casing made fireproof.

The positive and negative terminals connected to such conductors shall not be nearer to each other than 12 inches, and shall be efficiently protected from risk of contact.

Flexible conductors in connection with movable lights shall be insulated with vulcanised India-rubber, and protected on the outside by a stout braiding; should any of these flexible conductors be damaged, it shall be at once replaced.

No circuit of this nature shall carry more than 10 ampères, and each circuit shall be protected by a double pole fuse.

3. All conductors shall be efficiently protected from mechanical injury.

Where conductors pass through walls, fireproof floors, or ceilings, they shall be protected by iron pipes or by glazed stoneware or porcelain tubes, and precautions shall be taken to prevent the possibility of fire or water passing along the course of the conductors.

In special cases, or where necessary for protection from the depredations of rats, mice, or other vermin, armoured cables may be used. These need receive no further mechanical protection.

Lead-covered cables shall not be used unless protected by external armour of iron or steel.

Metal fastenings for fixing conductors shall be avoided; but when unavoidable some additional covering shall be used to protect the conductor, unless armoured, from mechanical injury at the points of support.

If casing be used, it shall be of hard wood, and each conductor shall be laid in a separate groove; the cover shall be secured with screws.

Casings shall, as far as possible, be placed in sight, and the conductors shall always be accessible.

Joints in conductors shall be avoided, but when unavoidable, they shall be electrically and mechanically perfect. Soldering fluids shall not be used in making such joints.

4. All external conductors shall be specially insulated and laid in iron pipes properly jointed, and of ample size.

Such iron pipes shall be protected where necessary, and securely fixed and supported when not underground.

5. All exposed metal work, such as fittings, switch and fuse covers, &c., shall be efficiently insulated from the circuits.

All switches, cut-outs, ceiling roses, wall and floor sockets, and lamp-holders, shall have uninflammable bases.

All switches shall be of ample size to carry the currents for which they are intended without heating, and shall be so constructed that it will be impossible for them to remain in any position intermediate between the "on" and the "off" positions, or to permit of a permanent arc.

All circuits shall be efficiently protected by cut-outs, placed in positions easily accessible to the staff, but inaccessible to the public.

The main cut-outs shall be of such pattern and be fixed in such a position as to admit of quick replacement.

All circuits carrying a current of 20 ampères or more shall be provided with a cut-out on each conductor, and the two cut-outs shall not come in the same compartment.

All cut-outs shall be so constructed that fused metal in falling cannot cause a short circuit or an ignition.

All cut-outs shall be so marked as to show what circuit or lamps they control.

All wall or floor sockets shall be provided with fuses in their fixed portions.

The sockets for the stage shall be of hard wood with metal guards, care being taken to avoid risk of ignition, and they shall be of specially substantial construction.

6. Resistances for regulating the power of the lights shall be mounted on incombustible bases, and shall be so protected and placed at such a distance from any combustible material that no part of the resistance, if broken, can fall on such material.

Principal resistances shall be placed in a fire-proof room reserved for the purpose.

7. Arc lamps shall not be used inside buildings without special permission from the council.

When they are used special precautions shall be taken to guard against danger from falling glass or incandescent particles of carbon.

All parts of the lamps, lanterns and fittings which are liable to be handled (except by the persons employed to trim them) shall be insulated.

8. Where there is a stage, special care shall be taken that all works in connection with the lighting of the stage are carried out in as substantial a manner as possible.

No metal work in connection with the circuits shall be exposed or so fixed or constructed as to be liable to cause a short circuit.

Lamps on battens, footlights, &c., shall be protected by stiff wire guards, so arranged that no scenery or other inflammable material can come in contact with the lamps.

No readily combustible material shall be used in connection with any lamps on the stage in such a manner that it might come in contact with the lamps.

No soft or readily inflammable wood shall be used in connection with the lamps on the stage, and all wood shall be protected by uninflammable material from the possibility of ignition by an arc between any two parts of the two conductors, or by heated particles from any conductor or part of a conductor which may connect together the two main conductors.

Where a number of lights, as in the footlights, battens, &c., are supplied under control of one switch, and protected by one single or double pole cut-out, as the case may be, the conductors shall be maintained throughout of such a section that they will be effectually protected by the cut-outs against heating.

The leads to the battens shall be specially guarded, particularly at the points where they join on to the battens, and a sufficient length shall be allowed to prevent the leads receiving any injury through any movement of the battens.

The battens shall be suspended by at least three wire ropes attached to insulators on the battens.

On no account shall the same battens be adapted for both gas and electric light.

9. A switchboard, containing all the necessary switches, cut-outs, and other fittings for the control and regulation of the stage lighting, shall be fixed in some convenient position overlooking the stage.

This board shall be inaccessible to all but the persons employed at such premises to work it.

10. Boilers, steam engines, gas engines and dynamos, when used for the supply of electricity to such premises shall be placed in such positions as shall be sanctioned by the council.

Gas engines shall be placed in rooms so adequately and continuously ventilated that no explosive mixture of gas can accumulate by any leakage through the engine in the event of any of the gas cocks being left turned on.

A hood, connected with a pipe carried into the external air, shall be fixed over the ignition tube when this is used.

11. Primary or secondary batteries shall be placed in rooms so adequately ventilated that no fan shall be necessary.

The batteries shall be well insulated.

12. Transformers used to transform either direct or alternating currents, together with the switches and cut-outs connected therewith, shall be placed in a fire and moisture proof structure.

Where the primary current is of high potential, such structure should be preferably outside the building.

No part of such apparatus shall be accessible except to the person in charge of its maintenance.

No transformer which, under normal conditions of load, heats above 130 degrees Fahr. shall be used.

Transformer circuits shall be so arranged that under no circumstances shall a contact between the primary and the secondary coils lead an electromotive force of high pressure into the building. The term high pressure means in all cases pressure above 200 volts.

13. The insulation resistance of a system of distribution shall be such that the greatest leakage from any conductor to earth, when all branches are switched on, the lamps and motors being removed, shall not exceed one fifteen-thousandth part of the total current intended for the supply of the said lamps and motors; the test being made at the usual working electro-motive force. Provided that this rule shall not be held to justify a lower insulation resistance than 5,000 ohms, nor to require one higher than 5 megohms.

14. The generating plant and switching gear shall be in the hands

of thoroughly competent manipulators, and the engine room (if any) shall be inaccessible to the general public, and shall, where possible, have an independent entrance.

15. A plan of the wiring shall be always kept in a prominent position in the office of the manager of such premises.

The following report of the Highways Committee was presented:—

Electric Lighting—Applications for Provisional Orders, 1892.

We have had before us the provisional orders, seven in number, for which application has been made by companies or persons to the Board of Trade, relating to electric lighting schemes. These are as follows—

Name of Order.	Area of Supply.
County of London (North) ...	Parishes of Islington, Clerkenwell and St. Luke; Holborn district.
County of London (South) ...	Parishes of Lambeth and St. George-the-Martyr; Wandsworth district.
East London (Hackney) ...	Hackney district.
North London...	Hackney district; Parishes of St. Luke and Clerkenwell.
St. Mary, Islington	Parish of Islington.
South London...	St. Olave's and St. Saviour's districts; parishes of St. George-the-Martyr and Newington.
West London	Parishes of Hammersmith, Fulham and Battersea; Wandsworth district (part of).

These orders are generally in accordance with those passed last year, and are based upon the model form No. III., issued by the Board of Trade in November, 1891, which differs but very slightly from orders approved by the council last year. We have examined all these orders; and as representations should have been made to the Board of Trade with reference to them by January 15th, we have, in order to prevent further loss of time, directed that certain amendments which we consider should be made therein shall be at once submitted to the Board of Trade, and that the Board shall be informed that where powers are sought with respect to the same area by the local authority thereof and by a company, the council is of opinion that the claims of the former should be preferentially considered. We recommend that the course taken by us be approved.

We have also considered a model order (form No. IV.), forwarded by the Board of Trade for the council's observations, for use in cases where the local authorities are the undertakers. There are four of these orders applied for this session, viz.:—

Name of Order.	Area of Supply.
Hampstead	... Parish of Hampstead.
Lambeth	... Parish of Lambeth (part of).
Shoreditch	... Parish of Shoreditch.
Whitechapel District	... Whitechapel District.

We have directed that certain amendments, which we think necessary to make the form of order correspond with previous legislation, shall be submitted to the Board of Trade, these amendments relating principally to the insertion of clauses relative to the keeping of separate accounts, removal of existing overhead lines, inspectors' fees, protection of the council's works, regulation of price, &c. We recommend that the course taken by us be approved.

Wandsworth District Electric Supply Order, 1890.

We reported on December 23rd last that the Board of Trade proposed, subject to any observations which the council might wish to offer, to revoke this order, the undertakers having failed to satisfy the department of their ability to discharge the duties, or to make the deposit required by section 7 of the order; and the council, on our recommendation, decided to offer no observations, and to leave the matter to be determined by the Board. We have now to report that formal notice of the revocation of the order has been received from the Board of Trade.

Notices under Electric Lighting Acts and Orders.

We have considered a notice, dated January 18th, 1892, from the Kensington and Knightsbridge Electric Lighting Company, of a proposed extension of mains in Queensberry Place. There is no objection to these works, and we recommend that the sanction of the council be given to the works referred to in the notice dated January 18th, 1892, of the Kensington and Knightsbridge Electric Lighting Company.

A notice, dated January 21st, 1892, has been received from the St. James's and Pall Mall Electric Lighting Company of intention to lay mains along Piccadilly (part of), Duke Street, and Mason's Yard. The proposed works, which will be an extension of the company's trunk mains, completing the connection between its old and new stations, are of the usual character, and there seems to be no objection to them. We recommend that the sanction of the council be given to the works referred to in the notice dated January 21st, 1892, of the St. James's and Pall Mall Electric Lighting Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works.

We have also considered a notice, dated January 22nd, 1892, from the London Electric Supply Corporation, of intention to lay a short length of main in New Kent Road, from the corner of Walworth Road to the Elephant and Castle Theatre. The proposed works are of the same character as those approved by the council on previous notices of this company; and we recommend that the sanction of the council be given to the works referred to in the notice, dated January 22nd, 1892, of the London Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works; that the mains be laid under the footways, and be kept 9 inches below the under side of the paving wherever it is found practicable to do so; that the positions of the street boxes and the mode of construction of them, shall be submitted to and approved by the council's chief engineer; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected, where leaving the boxes, by an extra lead covering or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casing; and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps, in addition to any other covering.

We have also to report the receipt of the undermentioned notices, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid:—

From the Electricity Supply Corporation—January 15th, 1892, to 369, Strand; January 19th, 1892, to 3, Pall Mall East; January 26th, 1892, to 64, Strand; Electrical Supply Fittings Company's premises in Charing Cross Road.

From the St. James and Pall Mall Electric Lighting Company, January 18th, 1892.—To 16 and 216, Regent Street; Fisher's Club, Clifford Street; 44, Pall Mall; 14, St. James's Square; 192, Piccadilly; and 3, St. James's Street.

From the House to House Electric Light Supply Company, January 27th, 1892.—To 215, Cromwell Mansions.

GAS AND THE ELECTRIC LIGHT.*

MR. JOHN C. GILL, ASSOC. M. Inst. C.E., borough engineer, delivered an interesting lecture on gas and electricity to the members of the Peterborough Scientific Society, at the Museum, on Thursday evening, January 28th. Mr. Gill divided his subject into two portions—efficiency and cost. In dealing with the former he worked out a careful comparison between the efficiencies of the electric glow lamp and coal gas. "A comparison of the energy taken from the coal at the commencement and that delivered in light at the end is all that I propose. From the last Board of Trade return on the manufacture of gas in the United Kingdom, we find that in the year 1890 the total quantity of coal used for the manufacture of gas amounted to 10,240,000 tons, and this coal produced 103,100 millions of cubic feet of gas. This gives an average of 10,066 cubic feet of gas for each ton of coal. The total heating power of 1 lb. of coal of average composition amounts to 14,320 units—one English thermal unit being the heat required to raise one pound of water 1° Fahr., and is equal to 772 foot-pounds of work. The average quantity of coal used in making 1 cubic foot of gas is, from the foregoing figures, 0·222 lb., and allowing 5 cubic feet to give 16 candle-power for one hour, we get 11,520 foot-pounds energy in light from each 1·11 lb. of coal. But each 1·11 lb. of coal contains originally 12,059,412 foot-pounds of energy, so only 0·095 per cent. of the mechanical energy in the coal is utilised, or we may say the efficiency of coal gas is 0·095 per cent. Turning our attention now to lighting by electricity, the average consumption of ordinary coal used for the steam engines employed to drive the dynamos in central station lighting may be taken at 2½ lbs. per horse-power per hour. Each horse-power at the engine therefore absorbs 35,800 units of heat per hour, or 27,637,600 foot-pounds of work. Now, an incandescent electric lamp of 16-candle-power requires 60 watts of electricity per hour. The mechanical equivalent of one watt of electric current being 44·2 foot-pounds per minute, the 16 candle-power lamp uses 159,120 foot-pounds per hour. One horse-power would therefore supply 12·4 lamps each of 16 candle-power for one hour, or a total of 198 candles, which, at 12 foot-pounds per minute, would have a mechanical equivalent of 142,560 foot-pounds per hour. But we have seen that to get this energy at the lamps we have used coal at the boiler, the energy of which amounted to over 27 million foot-pounds, and working it out exactly the efficiency is 0·516 per cent. The respective efficiencies of coal gas and electricity are therefore, coal gas 0·095, and electricity 0·516 per cent., the proportion being as 1 to 5·4. Both processes seem at first sight to be exceedingly wasteful, as by the better of them there is less than 1 per cent. of the energy in the coal utilised, while more than 99 per cent. is wasted. But the great object of this comparison is to show that electricity will give five times more light than gas from the same amount of coal; or, to put it another way, 1 lb. of coal will give five times as much light when used through a steam engine and dynamo as when made into gas. This fact must, in course of time, tell in favour of electricity, because as the coal has to be won from greater and greater depths it must become more and more costly, and any increase in the price of coal will affect the cost of gas more than that of electricity. Gas, as you are all aware, is sold by the thousand cubic feet, but electricity cannot be so measured, and a new unit has had to be adopted. Electricity is therefore sold by the "Board of Trade unit," which is more conveniently known as the kilowatt, and is, as the name implies, equal to 1,000 watt-hours. But perhaps some of you may ask "what is a watt"? To express it as simply as possible a watt is the electrical energy developed by a current of 1 ampère at a pressure of 1 volt. These terms, I am afraid, seem rather formidable, but that is only on account of their strangeness. When electricity came to be a commodity of daily use it was necessary to have fixed units of measurements, but as it could not be measured by either the gallon or

* *The Gas World.*

cubic foot, or weighed by the pound, new units had to be determined, and these have now become legal standards. The time is coming when every ordinary mind will have a fixed idea of a watt of electricity, just as it has now of a gallon of water, a pound of soap, or a yard of ribbon. For the present purpose it is sufficient to bear in mind that the electrical energy of one watt is $\frac{1}{746}$th part of a standard horse-power. We have seen that an electric glow lamp of 16 candle-power requires 60 watts per hour of electricity. For 1,000 watts we should therefore have 265 candles. Taking each ordinary flat-flame gas burner to give the light of 12 candles for every 5 cubic feet of gas consumed per hour, we should have 2,400 candles for each 1,000 cubic feet of gas. The ratio between the lighting power of 1,000 cubic feet of gas and 1 kilowatt of electricity is therefore as 9 to 1, and, to be of equal cost, light for light, the price of 1 kilowatt of electricity should be $\frac{1}{9}$th of the price of 1,000 cubic feet of gas. With the price of gas at 5s. 4d. per thousand cubic feet, as in Peterborough, the price of electricity to supply the same light at the same cost should be 4½d. per kilowatt or Board of Trade unit. At Newcastle-on-Tyne the price is 4½d. per kilowatt, and, therefore, electricity is sold at Newcastle at the same cost, light for light, as gas at Peterborough. But it is hardly fair to want the electric light supplied at the same price as gas. It is so much brighter, purer, cleaner, healthier, and safer that its market value is higher. Thus we find that there is a great and constantly growing demand for electric light in Bradford, where it is sold at 6d. per kilowatt, although the price of gas is only 2s. 3d. per thousand cubic feet. The advantages of a purer means of artificial illumination are very apparent to those who use electricity. There is no burning up of the oxygen required for breathing; there is no giving off as products of combustion of poisonous gases, or other objectionable compounds to injure health and damage furniture. Electric lighting has, therefore, large collateral economic advantages when compared with gas. We may pursue this subject a little further by inquiring whether the present price of electric lighting will be maintained, or whether there is any prospect of its being cheapened; and the reply may be given with the greatest certainty that electric lighting will become much cheaper than at present. There is no probability of the methods or machinery used for generating and distributing the current being much improved. The day of experiment is passed, and the permanent electric lighting plants now being erected are amongst the most efficient of machinery. But there is a monopoly in the manufacture of the glow lamps which keeps up the price. Two years hence the Edison-Swan patents will expire, and the manufacture of glow lamps will become an open trade. Their cost will then be considerably reduced, whilst there is also a promise of their efficiency being increased. Another reason why we may safely predict a lowering in the price of electric lighting is that the interest on capital and the maintenance expenses of a large central station plant are just as heavy when supplying only one-third of their full capacity of lamps as they are when running with a full load. This is just what is happening now, and the electric lighting industry is passing through that season of heavy outlays and small returns through which every new industry has to pass. We know that this experience was exactly the same with gas when it was first introduced. We know that gas companies who are now paying handsome dividends failed to realise any profit at all during the first years of their existence, although the prices they charged were more than double the present prices of either gas or electricity. When we think of the sixty-one millions of money invested in the gas manufacturing industry of Great Britain, and remember how much human nature there is in a man, we cannot feel either wonder or surprise that the electric light is not on all occasions and in all places received with open arms; but whether we like it or not, there can be no denying the fact that the year just closed has been one of extensive and solid progress in electric lighting. It was only the Act of 1888 that made successful lighting by electricity supply companies possible, yet there are already companies registered whose authorised capital amounts to £5,300,000. This, I think, will compare favourably with any other new industry, and it must be borne in mind that this sum of five and a quarter millions devoted to electric lighting is independent of the electricity supply works established in many towns by the local authorities."

Technical points in the lecture were illustrated by glow lamps, lighted by batteries, lent by the India-rubber and Telegraph Works Company, of Silvertown.

PROCEEDINGS OF SOCIETIES.

Physical Society, January 22nd, 1892.

Prof. O. J. LODGE, D.Sc., F.R.S., Vice-President in the chair.

Messrs. J. B. Peace and E. G. Highfield were elected members of the Society.

Prof. G. F. FITZGERALD, F.R.S., read a paper "ON THE DRIVING OF ELECTRO-MAGNETIC VIBRATIONS BY ELECTRO-MAGNETIC AND ELECTRO-STATIC ENGINES."

The author pointed out that as the electro-magnetic vibrations set up by Leyden jar, or condenser discharges die out very rapidly, it was very desirable to obtain some means whereby the vibrations could be maintained continuously. Comparing such vibrations with those of sound he said the jar discharges were analogous to the transient sound produced by suddenly taking a cork out of a bottle; what was now required was to obtain a continuous electro-magnetic vibration analogous to the sound produced by blowing across the top of a bottle neck. In other words some form of electric whistle or organ pipe was required.

These considerations led him to try whether electro-magnetic vibrations could be maintained by using a discharging circuit, part of which was divided into two branches, and placing between these branches a secondary circuit tuned to respond to the primary discharge. This did not prove successful, on account of there being nothing analogous to the eddies produced near an organ pipe slit. The analogy could, he thought, be made more complete by utilising the magnetic force of the secondary to divert the primary current, first into one of the two branches and then into the other.

If spark gaps be put between two adjacent ends of the branches and the main wire, then the magnetic effect of the secondary current should cause the spark to take the two possible paths alternately.

Electrically driven tuning forks and vibrating spirals were cases in which magnetic forces set up vibrations, but here the frequency depended on the properties of matter and not on electrical resonance. The frequency of delicate reeds, could, however, be controlled by resonance cavities with which they were connected, and he saw no reason why the same action could not be imitated electro-magnetically, using an electric spark as the reed.

Referring to the properties of iron in connection with electro-magnetic vibrations, he pointed out that a prism of steel 1 millimetre long had a period of longitudinal vibration of about 1 millionth of a second, and, as this was comparable with the rates of electro-magnetic vibrations, the immense damping effect which iron had on such vibrations might be due to the setting up of sound vibrations in the material. Other methods of driving electro-magnetic vibrations had suggested themselves in the shape of series dynamos or alternators. The polarity of a series dynamo driving a magneto-motor, would, under certain circumstances reverse periodically and thus set up an oscillatory current in the circuit. Similar effects can be got from series dynamos charging cells or condensers. In an experiment made two weeks before, with Planté cells and a Gramme dynamo, reversals occurred every 15 seconds.

Greater frequencies might be expected with condensers, The latter case he had worked out theoretically. He had also tried experiments with Leyden jars and a dynamo, but got no result. This might have been expected, for the calculated frequency was such as would prevent the currents and the magnetism penetrating more than skin deep.

Calling the quantity of electricity on the condenser Q, the differential equation for a dynamo of inductance L, and resistance r, and a condenser of capacity K, is

$$L\ddot{Q} + r\dot{Q} + \frac{Q}{K} = \dot{L}\dot{Q}$$

or

$$L\ddot{Q} + (r - \dot{L})\dot{Q} + \frac{Q}{K} = 0.$$

If $\dot{L}$ be = 0 the solution of the equation is

$$Q = Q_0 \epsilon^{-\frac{r}{L}t} \cos 2\pi \frac{t}{T}$$

and the rate of degradation of amplitude depends on the factor

$$\epsilon^{-\frac{r}{L}t}$$

If, however, L be greater than r, the exponent of ϵ becomes +, and hence Q would go on increasing until limited by the saturation of the iron or the increased resistance of the conductors due to heating. A dynamo without iron, provided one could be made to run fast enough to send a current through itself, would be likely to give the desired effect. The author thought that by making such a dynamo large enough and its armature very long, it would be possible to get a frequency of about one million. Electrostatic machines seem, however, to be more promising driving agents. Like series dynamos their polarity depends on the initial charge, and can be easily reversed. Hitherto such machines have been inefficient mainly on account of the sparking in them, but Maxwell had shown how this could be obviated. There was the same kind of difference between electro-magnetic and electro-static machines as between Hero's engine and the modern pressure engine. Like modern engines electro-static machines worked by varying capacity, but the effect of this variation in electro-static machines was only to vary the frequency and not the rate of degradation. From the fact that electro-static multipliers could be driven by alternating currents, he thought they might be made to drive alternating currents. If magnetic currents could be obtained, then electro-static engines would easily be produced. In conclusion, the author described a modified electro-static multiplier which he believed offered a feasible solution of the problem. In this machine the collectors were supposed joined to the ends of the vibrating circuit and would therefore become + and − alternately. Inductors and brushes were to be so arranged that an insulating cylinder turning between them should have many + and − charges distributed alternately round its periphery. By suitable adjustment these charges could be collected at the proper instants so as to keep up the vibration.

The CHAIRMAN (Prof. Lodge) said the paper was very suggestive and full of interesting points. The subject of electro-magnetic vibrations was attracting great attention in America in connection with the manufacture of light. Hertz oscillations die out too soon to be satisfactory, for their duration rarely exceeds a thousandth part of the interval between consecutive discharges. The theory of dynamos charging condensers he considered extremely interesting, and thought the fact that the damping factor could be changed in sign must have tremendous consequences.

Dr. W. E. SUMPNER asked a question about a method of doubling frequency of alternation recently described by Mr. Trouton, in which the armature of one alternator excites the fields of a similar machine. Mr. Trouton had said that after once doubling the frequency it was not possible to go on doing so. He (Dr. Sumpner) thought that by

adding other machines the frequency would be still further increased, and gave a proof of the fact.

In reply, Prof. FITZGERALD said that adding another machine increased the frequency by a given amount, and did not double the preceding one. Hence, to increase the frequency a thousandfold, a thousand machines would be required, and on this account Mr. Trouton considered it impracticable.

Prof. S. P. THOMPSON thought the paper very suggestive, and the acoustic analogies very interesting. Melde's apparatus was an instance of doubling or halving a frequency. On reading the title of the paper, he had expected hearing of a method of maintaining electro-magnetic vibrations by giving occasional impulses in some such way as that in which a tuning fork could be kept vibrating by allowing the hammer of a trembling bell to knock against it. There was another method of intensifying electric oscillations which he had seen mentioned in a patent specification by Sir W. Siemens, who suggested using a series dynamo with a telegraph cable, to augment the signalling currents. On the subject of ironless dynamos he (Prof. Thompson) desired further information. Some years ago he had made calculations, and found the speed at which they would require to run was so enormous as to be beyond the range of engineering possibility.

Mr. C. V. BOYS, referring to the author's suggestion of using an electric spark with alternate paths to maintain vibration, said that he had tried whether an oscillatory spark was displaced by a magnetic field, but the displacement, even when photographed by a revolving mirror, was barely appreciable.

Prof. PERRY asked for an explanation of the term "skin deep magnetism." He was not previously aware that Sir W. Siemens had described a method of improving cable signalling by using a series dynamo. He, himself, had patented a somewhat similar arrangement. He had also made a dynamo without iron, but had not got it to work.

In reply to Prof. Perry, the AUTHOR of the paper said that in electro-magnetic vibrations, the magnetic force alternates so rapidly that it could not penetrate far into the field magnet of a dynamo before it is reversed, hence the magnetism would be only skin deep.

Dr. BURTON suggested that a commutator with many segments, something like that used by Mr. Gordon in his researches on Specific Inductive Capacity, might possibly be employed for producing high frequencies.

NEW PATENTS—1892.

1,426. "Improvements in electrical batteries." C. G. MOOR. Dated January 25th.

1,436. "Improvements in friction driving gear for dynamo-electric and other like machinery." J. Y. JOHNSON. (Communicated by A. de Bovet, France.) Dated January 25th.

1,442. "Improvements in the manufacture and production of electro-plated metal sheets or articles." T. PARKER and J. WAKEFIELD. Dated January 25th.

1,459. "Apparatus for adjusting commutators of dynamo-electric machines and motors to varying speed." W. WHITE, J. RADCLIFFE and F. W. COOKE. Dated January 25th.

1,464. "Improvements in holders or sockets for incandescent electric lamps." T. JENNER. Dated January 25th.

1,479. "An electrical signalling and braking apparatus specially applicable to railway trains." G. HAMILTON and E. C. DAY. Dated January 26th.

1,484. "Improvements in and relating to secondary batteries." J. B. ENTZ and W. A. PHILLIPS. Dated January 26th. (*Complete.*)

1,497. "Improvements in couplings for electric wires." A. SHIELS. Dated January 26th.

1,552. "Improvements in telephone transmitters." J. GOFFIN. Dated January 26th.

1,557. "Improvements in electro-magnetic apparatus for producing a reciprocating motion, and for supplying intermittent electric currents for that purpose." R. THRELFAL. Dated January 26th. (*Complete.*)

1,580. "An improved electric low water alarm." S. M. MATHEWS. Dated January 26th. (*Complete.*)

1,626. "An improvement or improvements in the holders or carriers of electrical incandescent or glow lamps." R. G. EVERED. Dated January 27th.

1,637. "Improvements in and connected with telephones." G. L. ANDERS and W. KOTTGEN. Dated January 27th.

1,641. "Improvements in electro-motors for electrically propelled vehicles." A. SIEMENS. Dated January 27th.

1,656. "Improvements in electric brakes." J. Y. JOHNSON. (Communicated by A. de Bovet, France.) Dated January 27th.

1,666. "Improvements in electrically-operated means for preventing railway collisions." G. COLES. Dated January 28th.

1,682. "Improvements in electrical arc lamps." O. FIRTH. Dated January 28th.

1,695. "Improvements in instruments for the measurement of electromotive forces." T. PARKER and W. ARMISTEAD. Dated January 28th.

1,734. "An improvement in electric compasses and course recorders." J. VON PEICHL. Dated January 28th.

1,737. "Improvements in electric clock mechanism." A. J. BOULT. (Communicated by F. A. Ellis.) Dated January 28th.

1,746. "Howard's magnetic carrier." J. HOWARD. Dated January 29th.

1,748. "Improvements in dynamo-electric machines." E. CONRADY and G. W. BROWN. Dated January 29th.

1,752. "Improvements in microphones." G. BINSWANGER. Dated January 29th.

1,786. "Improvements in or relating to tanning by electricity." R. PINNA. Dated January 29th.

1,829. "A portable electric planing and polishing machine." M. SUTHERLAND. Dated January 30th.

1,852. "Improvements in apparatus for registering electric and other currents." H. RAISON. Dated January 30th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

20,896. "Improvements in apparatus for regulating electric currents or electric potential. A. GAY and R. HAMMOND. Dated December 22nd. 11d. The regulating apparatus comprises a resistance that is connected at its ends to the two points between which a constant current, or constant potential is to be maintained; in the case of alternating currents this resistance may be inserted in the exciter circuit, or as a shunt to the exciter field magnets; a contact arm or lever capable of cutting out or putting in circuit more or less resistance, according to the direction in which it is moved; two electro-magnetic devices for actuating the said regulator arm in opposite directions; and a relay adapted to bring one or other of these devices into action, the relay being operated by a third electro-magnetic device, the winding of which is arranged either in parallel with the electric generator, or in series therewith according as the apparatus is intended to maintain a constant potential, or a constant current. The arrangement is such, that when the current or potential between the two points rises above the normal, the relay will operate to close the circuit of one of the two first-mentioned electro-magnetic devices, which will cause the regulator arm to move and introduce more of the resistance into circuit, and when the current or potential falls below the normal, the relay will break the circuit of the first-mentioned device and complete that of the second, which will then move the regulator arm in the opposite direction, so as to cut out or short circuit a part of the resistance, thereby maintaining a constant or approximately constant current or potential, as the case may be, between the two points desired. 2 claims.

20,898. "Improvements in dynamo-electric machines." H. H. LEIGH. (Communicated from abroad by E. L. Desroziers, of Paris.) Dated December 22nd. 8d. Each conductor is wound on a self-induction device, with a magnetic circuit more or less closed, and a suitable resistance is combined with the magnets. This resistance can be wound wholly or partially on the said self-induction apparatus in the same or opposite direction of the helices or magnets. Therefore, whatever may be the position of the brushes whenever a set of coils is short circuited under the brushes, the excess tension of current is forthwith modified. Then, when the set of coils comes out of short circuit, the potential energy of the circuit and of the self-induction apparatus passes into the circuit of the said helices and resistances. 6 claims.

21,031. "Improvements in the production of lead plates or electrodes for secondary batteries, and the connections, straps, or lugs to the same." P. J. DAVIES. Dated December 24th. 1s. 6d. Relates chiefly to the production of lead plates, preferably of a gridiron or herring bone shape, viz.: a plate having on the surface a number of stand up ribs, feathers, or bars, which are produced by pressing the lead plate through a suitable die. Also relates to the casting of the lugs or straps of lead, or the lug connections to electrodes in general. This lug is made in a suitable mould by placing the end or edge of the lead plate or electrode partially in or against the mould, so that the edge of the lead plate forms a kind of stop, edge, or wall of the said mould. Lead is then poured and a blowpipe applied to cause the lead plate and the lug connection or strap to flow together, and thus make the lugs and connections at a greater speed than heretofore. 7 claims.

1891.

248. "Improvements in mechanism for transferring electric car batteries." F. G. CORNING. Dated June 9th, 1890. (Under International Convention.) 8d. Consists, in conjunction with a horizontal transferring surface or way upon or through which the batteries are to be shifted, of propelling wheels or rolls stationed in the paths of movement of the battery-trays, to engage them either by frictional or positive contact; and the invention also consists, in conjunction with such rolls or other propelling surfaces in the paths of the several trays, of means for moving all of the said surfaces (or any plural portion of them) simultaneously from a common point or source of power application; and, moreover, in disconnective transmitting mechanism for driving the propelling surfaces of the charging benches, the car receptacles, or other horizontal ways that are brought into temporary coincidence. 3 claims.

641. "Improvements in electric clocks." E. G. HAMMER. Dated January 13th. 8d. The improved clock measures time through the action of any suitable escapement which is driven by a spring that is wound at intervals by means of an electro-magnet. The excitation of this magnet is determined by a circuit-closer, which closes the circuit at regular intervals of time, and is operated

by the escapement. The action of the magnet not only rewinds the escapement spring, but performs the mechanical work incident to the advancing of the hands, or other indicating devices of the clock to denote the time. 5 claims.

675. "A new or improved regulator for electric generators and motors." R. E. BALL. Dated January 13th. 6d. Consists in making the yoke of the brushes of magnetic material, and constructing it so that it has two axes of different magnetic resistance at right angles to each other, and placing the yoke, or the portion of it which has the axes of differing magnetic resistance, in some part of the magnetic circuit of the machine, and so as to be free to move as required. 3 claims.

860. "An electric bell repeater, applicable as an electric bell and receiver for electric signals." A. H. BAGNOLD. Dated January 17th. 6d. An electro-magnet is arranged so that lines of force issuing therefrom pass through the sound-bow of a gong or bell, made of iron, steel, or of other magnetic metal. The coils of the electro-magnet are placed in the bell circuit. Whenever this circuit is broken, the gong or bell is set into vibration giving out clear and distinct rings, suitable for repeating the rings of an ordinary chattering electric bell, or for repeating the action of any other description of electrical make and break apparatus, thus acting also as an electric bell and as a receiver for electric signals. 1 claim.

908. "Improvements in insulators for electric wires." F. A. ROSS. Dated January 17th. 6d. Consists in an insulator threaded internally to receive a supporting pin, and provided with a watershed at its lower end, and at its upper end with a screw-threaded transversely-slotted part for receiving the wire, the insulator at the bottom of the transverse slot being concaved or corrugated to antagonise a screw having a similar surface, and a screw adapted to the threaded portion of the insulator for clamping the wire upon the corrugated surface of the insulator. 2 claims.

2,297. "A method of and apparatus for prolonging the life of the carbons in electric arc lamps." C. W. HAZELTINE. Dated July 9th, 1890. (Under International Convention.) 8d. The inventor applies, in close proximity to the arc, a protective tip or shield to prevent the rapid consumption of carbon. This tip or shield is, in the ordinary forms of arc lamp, fed as the opposite carbon wears away, and is automatically adjusted by any suitable means, but, by preference, is fed by the movement of the upper carbon, to which it is preferably applied. 4 claims.

3,338. "Improvements in telegraphy." J. A. PARKER. Dated February 24th. 8d. In letters patent of the United States granted to M. M. Bartholomew, No. 215,554, dated May 20th, 1879, and No. 255,910, dated April 4th, 1882, is described a machine and system for rapid writing, making use of nine keys, viz., a key for each finger and one key for the two thumbs, and whereby the hands may be used alternately to produce marks transversely across a paper ribbon. This machine has been improved and perfected, and is in general use for the purpose intended, under the name of the "Stenograph." The object of the invention is to utilise this machine, modified to suit the purpose. It may be used with any, or almost any, one of the methods already known for synchronous transmission of a number of messages over one wire or a number of wires. 4 claims.

3,364. "Improvements relating to the manufacture of incandescent electric lamps." H. H. LAKE. (Communicated from abroad by W. E. Nickerson and A. Berrenberg, both of America.) Dated February 24th. 6d. The object of the invention is to automatically cut out the current of electricity from incandescent lamps that are "running on the pumps" when from any cause air flows into them, as may happen from breaking or from inadvertent manipulation. 1 claim.

3,589. "Improvements in electric batteries." H. H. LAKE. (Communicated from abroad by W. B. H. Dowse, of America.) Dated February 27th. 6d. Consists of an improved battery wherein, by the peculiar arrangement of the solutions with reference to the elements of the battery, local action is entirely done away with, and from the fact that there is absolutely no chemical action except when the circuit is closed it becomes unnecessary to amalgamate the zinc plate used therein.

3,675. "Improvements in apparatus for the transmission of telegraphic messages by means of direct or alternate electrical currents." E. EDWARDS. (A communication from abroad by D. Kunhardt, of Germany.) Dated February 28th. 8d. Has for its object an apparatus for the transmission of telegraphic messages, by means of which signs can be transmitted by direct currents of electricity, that is to say, currents passing in the same direction, and earth connections; or by alternate currents, according to the interpositions of a contact plug, the necessary relay being switched in after each sign. 1 claim.

3,740. "Improvements in electric meters." M. KOECHLIN. Dated March 2nd. 8d. Relates to a construction of electric meters which is based on the principle of the Wheatstone bridge.

3,867. "Improvements in electricity meters." RANKIN KENNEDY. Dated March 4th. 6d. Consists principally in combining an ammeter or wattmeter with two pendulums and a differential gearing, the lengths of the pendulums being controlled by the ammeter or wattmeter, and the differential gearing recording their difference of vibration. 2 claims.

4,271. "Improvements in and connected with electrical railway signalling." P. A. NEWTON. (Communicated from abroad by the American Electric Railway Signal Company, of New York.) Dated March 10th. 8d. The general object of the present invention is to provide an improved electric railway signal system, by which an alarm shall be given in the cab of a locomotive, or at some other suitable part of the train, as it enters upon a block, in case a predetermined succeeding block be occupied by a train, whether stationary, or moving in the same direction as the train in which the signal is given, or in the opposite direction. Further objects of the invention are to provide an improved electric circuit system of general application in electric railway signals, whether the signal be transmitted to a part of the train or to a stationary signal device, and independent of the special form of signal device employed, and to provide an improved signal device which may be used with other electric circuit systems. 21 claims.

5,021. "Improvements in electric accumulators." H. H. LAKE. (Communicated from abroad by G. Gandini, of Italy.) Dated March 20th. 4d. An accumulator constructed according to the invention has its two electrodes formed of a mixture of lead oxide and small pieces of carbon. The two electrodes are separated by porous partitions of any suitable form. 1 claim.

5,247. "Improvements in electric heating apparatus." M. W. DEWEY. Dated March 24th. 6d. The object of the invention is to provide a material with which to surround or cover the resistances or wires that will not conduct electricity, will conduct the heat slowly, but with sufficient rapidity to prevent the burning of the wire, and to provide a material of sufficient flexibility and elasticity to maintain the same in close and constant contact with the conductor during all temperatures. 2 claims.

MORE NEWSPAPER SCIENCE.

THE lecture of Mr. Tesla was little short of an inspiration to the ordinary ready-made or newspaper scientist. In many cases the deductions they have drawn from his remarkable experiments are second only in ingenuity to the results themselves. If the public will but follow the lines laid down by these far-seeing men, the question of "the overcrowding of cities" will soon give place to the most important, and far more general one, of "the total extinction of man." The following is an extract from the *Weekly Dispatch* :—

> The amazing thing is that the stronger the current, the less is the injury to any living body through which it passes. Mr. Tesla risks his own life with great coolness in demonstrating this. *He makes his own body part of a circuit where the current at one end is so strong that it gives out a dazzling light, and at the other causes a vacuum tube to glow brightly, yet with this terrible current of force rushing through him he stands unhurt.* The thing would be deemed a miracle were it not that it actually occurs.

The *Referee* is no less demonstrative, and a great deal more original. Its readers are taught the meaning of electrical "efficiency," thus :—

> The great difficulty in the way of the electrician at present is, that he does not know how to economise the force he deals with. He wants light, let us say, but he cannot produce it without heat and chemical effect as well, for which he may have no need. The fable of the Chinaman and his roast pork exactly illustrates our case. The Chinaman became acquainted with roast pork through the accident of his house being burnt down with a pig in it. Thereafter, whenever he wanted roast pork he could think of no means of getting it except the costly one of burning down a house. In pretty much the same fashion we stumbled into using electricity for lighting purposes, and we are still in the rude stage of having to burn our house down in order to obtain our roast pig. When we can do with our electric lighting what we now do in the case of our pork—that is to say, expend just as much energy upon it as is requisite to produce the desired effect and no more—the greatest commercial problem of the day will be solved.

In the same figurative manner the writer discourses upon the probable character of electricity itself. He comes to the conclusion, however, that it is still a mystery, and "all we can say is that if we scratch the earth's crust in a particular way, electricity is accumulated there." The result arrived at being that even Mr. Tesla, on this point, "himself knows no more than the man in the street." We then have brought before us "the astounding fact that the lecturer was able to pass through his body, without feeling it, a current nearly 50 times stronger than that used to execute criminals." After a short discussion upon "etheric vibrations," the article descends to a practical climax.

> In the midst of endless speculations as to what may or may not be, there is one small grain of fact worth noting. The mode of executing criminals by electricity requires amending. It is clearly a mistake to make the current as strong even as 2,000 volts. I would try 500 or 800. The higher you go, as Mr. Tesla has shown, the less dangerous the current becomes. Very curious is this.

Very! Can it be that even "Mustard and Cress" is better taken *cum grano salis*.

A few weeks ago the *Standard*, in describing high tension current apparatus, spoke of a two foot spark which would pierce the human body like a *bayonet shot from a gun*. If the gun had been shot from the bayonet, or the shot

bayonetted from the gun, it would not be so very wonderful, as these little eccentricities on the part of modern implements of warfare are as common as the targets dodging bullets at the annual meetings of the National Rifle Association. Still, as an example of imagination and descriptive power, we thought this would be hard to beat, until we read the *Daily Telegraph's* article on the Crystal Palace Exhibition, which appeared on Wednesday morning, and to show how alive the leading newspapers are to the necessity of securing the best available scientific writers, we give below a few extracts from the paper with the largest circulation in the world.

Now, as has already been explained in the *Daily Telegraph*, the consumer can, by the Crompton system, have electricity laid on to his premises as readily as gas. But let no one suppose that this brilliant white light is the actual illumination produced by the mystic force of which the Sydenham gathering is the latest illustration. "Electric light" is simply the outcome of electricity, used in combination with carbon, copper, and other agents. Perhaps no better example of what "electric light" really is can be offered than by the magnificent machine shown by Messrs. Siemens, which, for the first time on record, gives a power in public of over 52,000 volts. At a private trial given the other day before Sir Benjamin Baker, Mr. Siemens and Captain Henshaw Russell, some wonderful results were obtained in the Lecture Hall, where sight-seers are now privileged to witness "thunder and lightning" manufactured by human agency. After causing water to boil in the space of 30 seconds, the current was turned on to 500 105-volt lamps, arranged in series—that is to say, every lamp was in communication with its neighbour. It would have required some 55 horse-power to turn them under ordinary conditions, but the wire used was less than a millimetre in diameter—say about $\frac{1}{25}$ of an inch, or about the size of a common pin. Beginning with a pressure of 20,000 volts—5,000 more than were used last year over the distance of seventy-eight miles between Lauffen and Frankfort—the current was gradually raised to 52,500 volts, amid the anxious and excited remarks of the few spectators. The lamps glowed and occasionally cracked; but the experiment was in every way successful.

CORRESPONDENCE.

Secondary Battery Plates.

In your issue of December 11th, you quote from the *Scientific American* a paragraph which attributes to Mr. Edison of America the preparation of certain plates of secondary batteries:—"A solution is made by boiling litharge in a very concentrated solution of caustic soda and potash. A lead plate boiled in this solution will receive a coating of spongy lead half-inch in thickness. This can be pressed down so as to occupy only $\frac{1}{100}$th of an inch. A plate thus prepared yields readily to the forming process."

This invention was first patented in Italy and foreign countries by Signor Giovanni Garassino, and registered in England January 30th, 1890, No. 1,629.

Kindly rectify and oblige.

Girolamo Taddei.

February 5th, 1892.

Electrolytic Alkali.

Referring to a letter signed "Chemical Manufacturer" in your last issue, as I am much interested in the application of electricity to the chemical arts, I should be glad to know whether any definite and practical results are known respecting the process mentioned in your correspondent's letter at present in use at Snodland (Kent), and whether such results have been published.

Electrolysis.

Electric Organ Control.

As I notice in your last week's issue a letter from Mr. Robert Hope-Jones in reference to my letter published in your REVIEW of January 29th, I wish to be allowed to say a few words, with the view to correct a wrong impression, as it seems to me the above gentleman has fallen into error in judging the same.

In the first place, I must say it never entered my mind that his electro-pneumatic action is identical to mine, but simply said that my action leaves nothing to be desired for electrical transmission in organ playing, as experience has proved it. With regard to the organ he mentions, for which his advice has been asked, I do not know whether the same has been constructed with my electro-pneumatic action. However, even if it were, I think it has been constructed with an old fashioned style of sound-board, otherwise I should think a mere exaggeration the assertion that it needs 30 Léclanche cells to work it. Although my action was designed to be used in connection with the old system of sound-boards for which it needed two little bellows for opening the pallet, it is now entirely used by organ builders in this country with the new system of sound-board made of a series of small valve bellows opening wind directly into the sound-board, by which system one of the intermediate little bellows is done away, thus gaining rapidity in action and simplicity in construction. The organ in the Palermo Exhibition, as constructed by Cavaliére Pacifico Juzoli, of Crema (for which I furnished the necessary electrical material), contains the latest perfection in the art of organ building, the greater part of which are due to the indefatigable labours of that distinguished organ builder. Though the electro-pneumatic action is the same in form and size as others previously made, the iron armature is a little lighter than former ones. Formerly it weighed about 4 grammes, now it scarcely weighs 3 grammes. The electro-magnet weighs about 165 grammes; both are made of best Swedish charcoal iron thoroughly annealed, the electro-magnet being wound with high conductivity green silk covered copper wire, the size of which I vary to suit the distance it has to work, or, in other words, the resistance of leading wire and battery. Experience has shown that when this action is working under a pressure of about 3 inches, *i.e.*, $\frac{1}{5}$th of an atmosphere with 1 mm. stroke, absorbing about 1·8 watts, the armature can play at the rate of 10 complete strokes per second, and this is rapid enough for all needs in liturgical music, and more than a human finger can do. Though Mr. Hope-Jones is perfectly right in condemning the old fashioned style of heavy magnets and armatures still used by some English organ builders (even of world's repute), he could hardly justify himself in tacitly calling my action of the same class. He made no mention in his paper of Schmolls's electro-pneumatic action, which, though having several electro-mechanical faults, was certainly a good step in the right direction. Apart from heavy magnets and armatures, some failures were due to organ builders using mercury contacts and others perpendicular metallic contacts, often with too limited surface and improper material for the heavy current used, all of which I have substituted with proper broad inoxidisable rubbing contacts. Like Mr. Hope-Jones, an electrician by profession, I have taken delight for some years past in all that concerns the modern liturgical organs. I may say that experience has taught me that there is very little advantage in the use of electricity for working side stops and swells (exception made for buttons in front of manuals) over the ordinary pneumatic system, that is, unless the distance between manuals and organ is very great, or, perhaps, where, in some particular case, owing to want of space, there is a difficulty in passing the necessary little pneumatic pipes.

It must be remembered that the primary advantage in the use of electricity in organ playing, is the lightness of touch, the organist working the keys with the same pressure with one, two, three, and even four manuals coupled, as he would exert for a single one—an advantage that is almost impossible to attain with the old mechanical system used. The advantage over the pneumatic system is chiefly for doing away with retardation, so manifest and inconvenient in rapid repetition notes. However, this rapidity in repetition need not go beyond what the human finger can accomplish, unless, of course, we choose to "grind" the manuals after the style of street tormenters!

In conclusion of my letter, and in observation to the last paragraph of Mr. Hope-Jones's letter, I may say that unless our knowledge of self-induction and of well-known magnetic laws lies somewhat near the tongs and poker of the old patriarchal fireplace, the above gentleman has hazarded an absurdity for which the proper answer might have been no answer at all.

A. E. Conti.

Genoa, *February 8th*, 1892.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

THE Lord Mayor and the Lady Mayoress, accompanied by Mr. Sheriff Tyler, Mr. Sheriff Foster, Sir John Monckton, and many others, went to the Crystal Palace on Saturday evening to inspect the Electrical Exhibition opened about a month ago. After a walk round, the visitors were entertained at dinner in the large saloon off the south transept. Among the company were the Attorney-General (Sir Richard Webster, Q.C., M.P.), Sir Robert Rawlinson, K.C.B.; Sir Frederick Abel, K.C.B., D.C.L., F.R.S.; Prof. W. E. Ayrton, F.R.S.,; Mr. R. E. Crompton,; Sir Henry Tyler, M.P.; Sir Eyre M. Shaw, K.C.B.; Major-General Webber; Prof. W. Crookes, F.R.S.; Sir Henry Mance; Mr. Tesla; Mr. W. H. Preece, F.R.S.; Sir James N. Douglass, F.R.S.; Major-General Festing, F.R.S.; Sir Arthur Otway; Col. Gouraud; Dr. Hopkinson, F.R.S.; Mr. Sidney Low; Mr. A. Siemens; Prof. Kennedy; Prof. Forbes F.R.S.; Prof. Robinson; Prof. Perry; Prof. Hughes, F.R.S.; Prof. Silvanus Thompson, F.R.S., and Mr. Perry F. Nursey. In the unavoidable absence of the chairman of the Crystal Palace Company, the Hon. D. J. Monson, the chair was taken by the deputy-chairman, Mr. G. T. Rait. After the usual loyal toasts,

The LORD MAYOR said that if the undertaking did not prove successful it might almost be regarded as a national calamity, for want of success would mean in substance that the electric light was a failure. But there was sufficient evidence to warrant him in saying that the Exhibition would prove a very great success. He recollected how, ten years ago, the electric light occupied the minds of many people, and how at that time the light had what proved to be a very bad start. The light was then undertaken more as a speculation. The public rushed forward eagerly; parent companies extended their arms, and the money went into the pockets of promoters. This checked for a time electrical enterprise, though, in his opinion, it had done no great or permanent harm. Though it had dawned upon us slowly, the electric light was coming steadily into public favour. He was told that there were in the Metropolis eleven electric lighting companies, with a capital of £4,000,000. This was a very great enterprise, though no greater than the object deserved, for they might depend upon it that, although great strides had been made since the Electrical Exhibition of 1881, still greater strides would be made. When he left the Mansion House he would have to go back to the comparative darkness of gas light in the village of Ewell, but he hoped that in a very short time we should all have the comfort of the electric light.

DR. HOPKINSON, in giving "Electric Science and Industry," remarked that the reaction between these two had been very intimate.

Prof. AYRTON, President of the Institute of Electrical Engineers, who responded, said that it was impossible to imagine what progress would be made in electricity in another ten years. At present two conductors were necessary for every electric tramcar. They had anticipated his joke. One conductor took the current, while the other took the current coin. It might be that in ten years street lamps would be no longer necessary, as vacuum tubes would be used for walking sticks. The smoke plague and fog would no longer trouble us, for there would be no coal fires when we could bask in the rays of the electric field, repose in the genial warmth of an equipotential surface, and put our feet on a fender composed of horizontal lines of force. One suggestion he would make—that the electric light might be introduced into that room, for the warmth they had borne during the dinner had been surpassed only by the warmth of their reception by the directors of the Crystal Palace.

Mr. Crompton, Mr. Preece, and other speakers followed.

Transformers.

The collection of transformers is by no means a large one, the most prominent being the Mordey-Victoria, and the Hedgehog transformers of Messrs. Swinburne.

As our readers are aware, the former type is of a very simple form, the points aimed at in the design being ease and simplicity of construction, accessibility (for examination or repairs), lightness (obtained by utilising the material to the best advantage), thorough lamination (for the prevention o wasteful internal currents), good ventilation, regulation, insulation and safety, magnetic circuit, and high efficiency at all loads. This is by no means a modest standard for which to strive, but "he who aims high never strikes low."

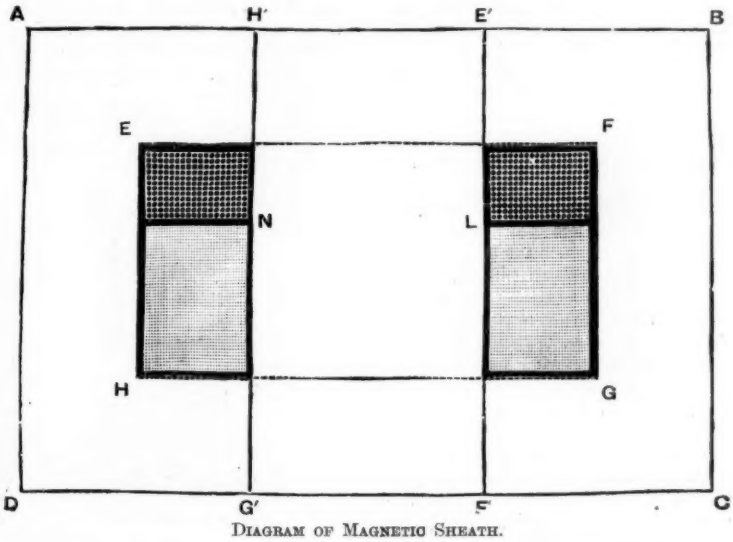


DIAGRAM OF MAGNETIC SHEATH.

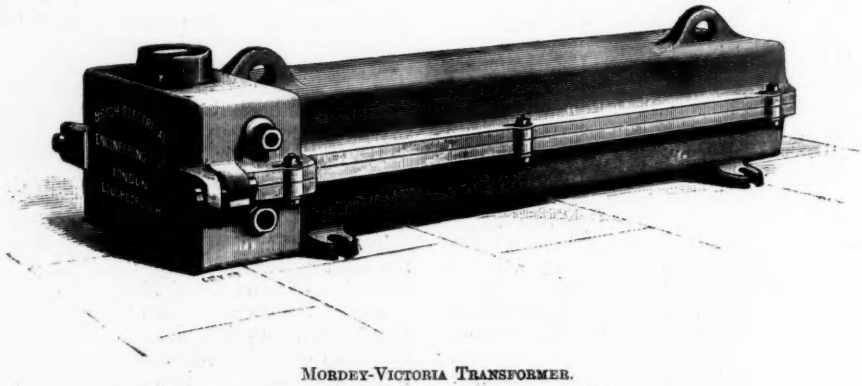
We give a diagram showing the magnetic sheath and electric conductors of the transformer in cross section.

The sheath is constructed in the following manner:—

Thin oblong plates, A, B, C, D, of the very best soft iron, have the part, E, F, G, H, stamped out of the middle of each, exactly equal in length to the breadth of the original plate. When this strip is placed across in the position, E, F, G, H, two rectangular openings are left, which are occupied by the windings of the primary and secondary coils, separated from one another by a sufficient thickness, N L, of an insulating material.

The coils are wound on a frame of such a shape, that each coil consists of two parallel straight portions, with rounded ends, the section being rectangular, and of such a size that the two coils just fill the openings in the plates. The larger pieces of iron, A, B, C, D, are slipped one by one over the coils, alternating with the narrower strips, E, F, G, H, which

are threaded through the coils; thus, with the exception of the rounded ends, the coils are wholly enclosed or encased in the iron sheath. When the requisite number of plates have been placed in position, they are clamped tightly together by bolts and nuts, and the transformer is then ready to be finished or mounted in any suitable way. It will be seen that this construction is very good and simple. While using the minimum of material it ensures almost perfect sub-division or lamination of the iron, giving the best and most unrestricted "magnetic circuit" with the greatest restriction to eddy currents. The coil being nearly all enclosed has scarcely any portion inactive. There is a small air-space between the plates, whence the surface available for ventilation is considerable.



MORDEY-VICTORIA TRANSFORMER.

The transformers, made in two classes, are finished and mounted according to the requirements of the user, and the position in which they have to be placed.

The standard electromotive force for ordinary purposes is: 2,000 volts for the primary, and 50 and 100 volts for the secondary.

The secondary conductor of each transformer is furnished with four terminals, to enable it to be used to give 50 volts or 100 volts, or both.

The primary pressure of 2,000 volts is chosen as being on the whole most economical. It is not high enough to necessitate "transforming up" at the generator (the alternators being easily made to give this pressure direct), nor to involve the use of special insulating arrangments. At the same time, it is high enough to be very economical in the size and weight of conductors. Moreover, with 2,000 volts the loss of power in the primary mains is very small, and the amount of variation from the standard pressure in the secondary working circuit is usually inconsiderable.

A lower pressure may be used, but it involves the use of more costly conductors. Or a higher pressure may be used, but although it allows of smaller conductors being employed, it is more costly on account of the greater expense of insulating materials and arrangement. On the whole, the pressure adopted in this system is the most advantageous for ordinary purposes. For special cases, however, as, for instance, for very long distance transmission, a higher pressure is resorted to.

Special transformers for three-wire working are made with one primary winding only, but with two secondary windings, each of 100 volts, thus enabling the double circuit to be supplied from a single transformer.

The efficiency, it is stated, varies according to the size of the transformer. The following values are claimed for an ordinary 6,000 watt transformer (100 16-C.P. lamps):—

Load.	Efficiency per cent.
Full	96·7
¾	96·2
½	95·1
¼	92·1
⅛	86·7
No load	Loss, 1·8 per cent.

These figures given for the half and quarter load are undoubtedly high, and are certainly not in accordance with the general notion concerning transformer efficiency.

For the open circuit type of transformer, we may mention the Hedgehog pattern. Messrs. Swinburne, in order to avoid the hysteresis loss, make a transformer which has very little iron, and which has a much higher all-day efficiency. To meet the difficulty of the idle current on open circuit, they have forestalled any objections by utilising thoroughly commercial alternate current condensers. The ordinary transformer for house-work, as well as two forms of street-lighters, are exhibited. In addition to the ordinary house transformer, we illustrate a small transformer with case, shade, and lamp-holder complete. This takes 2,000 or 1,000 volts, and has a 50-volt 32 candle-power lamp. The object of this is to provide incandescent lamps for street lighting without special secondary leads. One most interesting feature of this exhibit is a transformer giving, nominally, 100,000 volts. It is uncertain how much higher this transformer can be run without breaking down. This high-pressure transformer, is exhibited working on a condenser, and various experiments which the high-pressure make possible are performed. This kind of transformer has been, of course, designed for commercial use on cables. In order to test a cable of, say, 0·5 microfarad under 50,000 volts, with a frequency of 100, a current of 12 ampères must be available; 50,000

HEDGEHOG TRANSFORMER.

COMBINED TRANSFORMER AND LAMP.

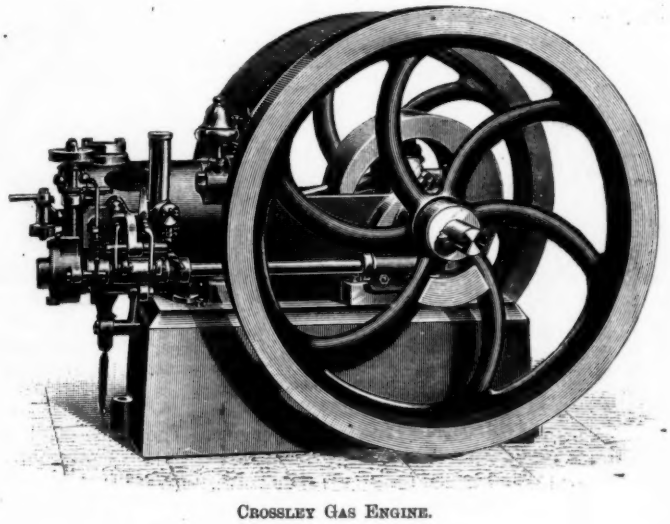
volts and 12·5 ampères make 625,000 apparent watts. Messrs. Swinburne & Co. have, therefore, patented a method by which it is not necessary to use a 625-kilowatt dynamo. A large adjustable choking coil takes or gives nearly the whole 12½ ampères. The dynamo and step-up transformer then supply quite a small current. There is another way of doing

the same thing. Suppose the dynamo gives 12·5 ampères and a few volts. One terminal of the dynamo circuit, and the outside of the cable, are then earthed or connected together. The other dynamo terminal is connected to the adjustable choking coil, which is in series with the inside of the cable. By this means 50,000 volts can be produced on the insulation of the cable. Messrs. Swinburne & Co. are supplying a large testing plant to one of the leading cable makers for testing a mile of cable at a time under high pressures.

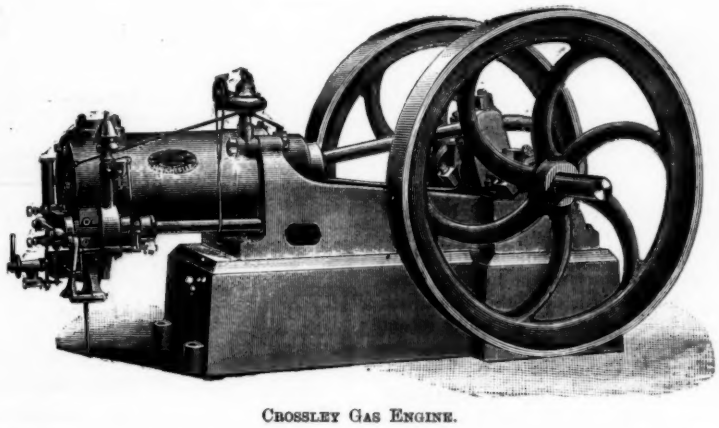
Gas Engines.

We have mentioned in a previous notice on the exhibition, the important part to be filled by gas engines in the future developments of electric lighting. Keeping this fact before us, we propose to fully describe the engines which are exhibited at the Crystal Palace. We might opportunely introduce a few remarks made by Mr. W. Norris, of Lincoln, before the Leeds Associated Engineers, on "modern gas engines."

Speaking of the Otto engine, the lecturer said: "The late Dr. Otto's name is known all over the civilised world as the inventor of the first economically and commercially successful gas engine. In fact, he may be called the inventor of the gas engine, in the same sense and with as much truth as James Watt is commonly called the inventor of the steam engine. By using the four-stroked cycle, Dr. Otto succeeded in using the motor cylinder as the compressor, and he arrived at a simple construction of engine, ingeniously designed in many of its parts, and which has substantially remained the same during the 16 years which have elapsed since its introduction; and most inventors who have been unaware of the simplicity of the four cycle engines, after lamentable errors, accompanied by waste of time and money, have ultimately adopted the Otto cycle. The Atkinson engine was also described and spoken of as the most economical engine in the market, as regards its gas consumption. The Robey gas engine (Richardson and Norris's patent), was illustrated by an engine in motion, which was the smallest engine made by Messrs. Robey, and also illustrated by complete full sized drawings and diagrams of a 9 H.P. (nominal) Robey engine. The safety combination and means for delaying the time of ignition, consists of a small screw, which permits of the engine being adjusted for high or low speeds. A peculiarity of the Robey gas engine is that it can be made to run in either direction in a few seconds. The measured drop lubricator was fully described and illustrated. The small engine which was working in the library of the Association was also described. The efficiency of gas engines with gas varying from 817 down to 620 British thermal units, was given in a tabular form. The practice of selling gas engines by nominal instead of brake, or actual economical working H.P., was strongly condemned. Speaking of the gas engine of the future, the lecturer looked for economy in a hot cylinder and a regenerator in some form or another."



CROSSLEY GAS ENGINE.



CROSSLEY GAS ENGINE.

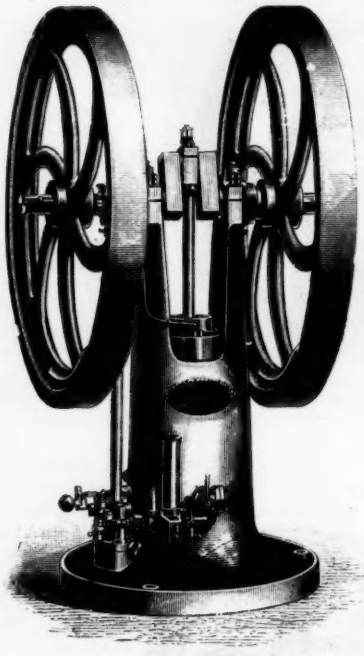
At the Exhibition a considerable display of engines, on the "Otto" principle, is made by Crossley Brothers, Limited. Many improvements have been made both in design and construction since the firm last exhibited on a large scale.

On their own stand (No. 44 Machine Room) four engines are shown.

No 1 is one of their new high-speed engines, "D" size, capable of developing about 6·3 brake horse-power. This is a very neat little engine, which runs at about 250 revolu-

tions, the speed being regulated by tightening or releasing a spring. It is very heavily flywheeled, and the speed is so regular that the firm guarantee absolute steadiness of lights when driven direct off the engine, without the usual flywheel on the dynamo. They calculate that with these high-speed engines they can give a 16 candle-power lamp for 2½ cubic feet of gas per hour. This is considerably less than half the quantity required to produce a similar light in a gas burner. No. 2 engine is an "E" size high-speed, on much the same lines as the "D," but capable of giving off about 8·5 effective horse-power. It runs at the same speed, and is perhaps a little better finished than the "D." Both these engines have very large crank bearings, are exceedingly strong and rigid in all parts, and most carefully balanced for high-speed running.

Messrs. Crossley Brothers, Limited, have for years been occupied in the development of a patent ignition tube, which would be indestructible. Their engines are all being fitted now with a patent tube, of which they are the sole licensees, and which promises exceedingly well.



CROSSLEY VERTICAL GAS ENGINE.

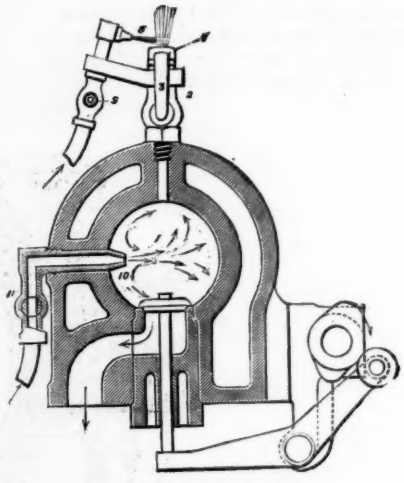
The other engines on Messrs. Crossley's stand consist of one of their recently-designed and extremely simple vertical engines, of 3 H.P. nominal, capable of indicating 6 H.P., and one of their new type 1 H.P. horizontal engines, capable of indicating 3·3 H.P. These engines are also fitted with the new patent permanent tube, as well as all other recent improvements.

On the stand of Messrs. R. E. Crompton & Co., Limited, is shown Crossley's 12 H.P. nominal engine, capable of indicating 28 H.P. This engine is fitted with Crossley's patent electric light governor, which we have previously described, and two specially heavy flywheels. It is also fitted with the new "Lanchester" patent self-starting apparatus, of which Messrs. Crossley Brothers, Limited, have acquired the sole right, and which we understand they are fitting to all engines of 9 H.P. (inclusive) upwards. The advantage of this apparatus, which we describe below, is very great. With it one man can start any engine up to 30 H.P. nominal.

On the stand of Messrs. Laing, Wharton and Down is one of Crossley's 14 H.P. nominal engines, capable of working up to 33 H.P., and similar to the above-mentioned 12 H.P.

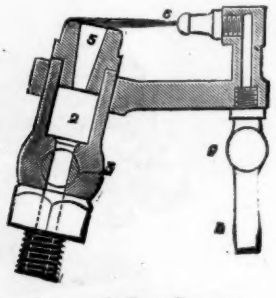
There is also shown the largest of the high-speed series of Crossley's engines, No. "F" size, capable of giving 14 effective horse-power, and similar in design to the above engines, except that it is fitted with the patent self-starting arrangement.

A self-starter enables a gas engine to be immediately started from a state of rest without manual labour, and without the complications incidental to previous self-starters. Our illustration gives a transverse section of a gas engine fitted with the apparatus. A nozzle, 10, opens to the explosion chamber of the engine and connects to a gas supply pipe by a cock, 11. A cock, 3, contains within it a valve in a cylindrical space at the position, 2, shown in section in the lower figure. The cylindrical valve in 2 rests upon the lower seat, and has grooves or channels round it, so that while on the lower seat free communication is open between the compression space, and the atmosphere, a flame jet, 6, is supplied by the cock, *g*, and is lit when it is desired to start



CROSSLEY'S SELF-STARTER.

the engine. The crank is set over the centre and a little forward, and the gas supply cock, 11, is opened. Gas then streams into the space, as indicated by the arrows, and mixes with the air contained in it, drawn in by the movement of the engine piston previous to stopping. Part of the air is displaced by the cock, 3, and valve, and passes through a nozzle, 5; at first air only passes out in this manner, but after a time gas and air mixture is discharged; this mixture lights at the flame jet 6 and burns in the atmosphere more



CROSSLEY'S SELF-STARTER.

vigorously as the mixture becomes richer. Whenever it is rich enough in gas, which can readily be seen by the colour of the flame or by the roar made by it, the gas cock, 11, is closed and the cessation of flow allows the flame to strike back through the nozzle 5 into the space, thus giving an explosion and starting the engine. The exhaust valve is held open during the whole compression stroke, so that the charge drawn into the cylinder by the movement of the piston consequent on the first explosion is not compressed, but is discharged at the exhaust valve and a little blown through the nozzle 5, where it lights at the flame 6 and fires back, when the rush through ceases at the end of each stroke. The cylindrical valve in the space 2 is forced up against its upper seat by the rush of gases due to each explosion, and so the cylinder is closed. When the pressure within falls to atmosphere again, the valve falls to its lower seat and leaves a passage open again.